"On certain Structures formed in the drying of a Fluid with Particles in Suspension."

By Catherine A. Raisin, B.Sc. Communicated by Professor T. G. Bonney, D.Sc., LL.D., F.R.S. Received March 16,—Read May 5, 1898.

(Plate 2.)

Part I.—1. Origin and Method of Experiments.
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Part I.

1. *Origin and Method of Experiments.*

I have frequently had to mount in water, for examination with the microscope, the powder of various rocks. Certain of the slides, when accidentally dried, exhibited rather interesting forms. These I showed to Professor Bonney, who encouraged me to try for further results, so the experiments were continued with various powdered substances—many pigments (vermilion, indigo, sepia, &c.), chalk and other more or less friable rocks. At first, ordinary microscope slides were used, but afterwards, larger pieces of glass, in each case, generally with a cover-glass placed over the mud. The results seem to be worth describing, as affording familiar, almost homely illustrations which may throw some light on the origin of certain minor structures in rocks.

2. *Classification of Forms.*

The chief effects produced may be shortly described. One form shown by the dried powder is that of a winding network (Plate 2, fig. 1), which is formed of bent stems, fairly uniform in thickness, giving rise to short branches in different directions, but generally at high angles. The whole makes a kind of maze in which the broader winding spaces often average from $\frac{1}{12}$ inch to $\frac{1}{6}$ inch in width. This form arises from desiccation of a fairly dense* mass. Where it is densest, a coarser maze is developed and the coarser part is earlier formed† (fig. 1 towards *a* and *b*).

* I use this term for a mass where the water is distinctly "muddy," *i.e.*, where the proportion of the suspended particles to the water is relatively high.

† Sometimes the denser mud has been carried forward apparently by the squeezing along of more suspended material (fig. 1). Sometimes a greater amount of the solid substance has been left behind, while a less dense mass was pressed forward. In slides left to dry in a tilted position, gravitation carried the greater amount of particles towards the lower end.

The meshes in the network may be occupied by a finer deposit arranged in successive curves. Within a coarser maze, the curves are closer, and the finer material forms a more conspicuous pattern.

In other examples, the thick streaks become less bent (*cf.* fig. 4; also fig. 2), and finally straight, sometimes with a terminal knob, sometimes forked or branched, generally at a rather acute angle. From these axes, finer pattern-marks seem to diverge on either side. Certain materials usually formed straight axes*—these were also developed in other substances under certain conditions, *e.g.*, when the mud was thin, or when its boundary was within the edge of the cover glass, or when a corner of the cover was upraised to allow quicker escape of the moisture. Thus the straight axes seem to be the result of a more ready retreat of the rim generally due to a freer evaporation. While, if the cover was sealed down with canada balsam, or if denser mud had spread beyond the edge and caked, so as to check evaporation,† a maze was produced.

A fine pattern may be formed either in connection with the thicker aggregates, or where these are wanting. It generally arises from a sorting of the material—the finer feathers and tufts are built of small grains, the thick coarse axes of larger. The fine particles may be spread almost continuously (*e.g.*, ivory black, light red), the deposit then becoming more concentrated towards a series of curving lines. Similar wave patterns may become fan-like from development of crossing radial curves‡ (fig. 3).

Transverse bars, also curved, extend between straight axes, where these are near together, and where the fine material is abundant in somewhat granular substances§ (fig. 2). The predominance of radial or of concentric or wave pattern is mainly due to the form of the area and mode of retreat, since they are shown in the same material. Feather forms are developed within confined areas, as in ovoid bubbles which are contained in the margin of a deposit of vandyke brown (fig. 4).

This example (fig. 4) also illustrates other forms. The mud dried, or partially dried, along part of the edge and water from the included mass then tried to escape. Thus, bubbles were formed, generally elliptical or ovoid, and elongated transversely to the

* Gamboge, Upper Headon marl, boulder clay, pipe-clay, some slides of chalk, a tendency in vandyke brown, sepia, vermilion, &c.

† This was shown in one slide of vandyke brown. In another slide of that material the cover was not sealed, and although the mud caked at part of the edge (the part figured in fig. 4), the water escaped along most of the sides, and straight axes were produced.

‡ Vandyke brown, Prussian blue, crimson lake, ultramarine, vermilion, sepia, chalk.

§ Like chalk, pipe-clay, &c; not smooth uniform substances, as vandyke brown, gamboge, &c.

edge, like vesicles towards the surface of an igneous sheet or dyke. Still more interesting are tapering pointed canals, some of which radiate from the bubbles or from a central point. Others are generally branched, often slightly curved, and have a central granular streak. Near the sealed edge, canals are numerous and vesicles are large and few; while beyond this part, the canals diminish in number and finally almost entirely give place to numerous but small vesicles. The intervening mud exhibits various contraction cracks which originated in drying.

Thus, the structures may be classified as :—

1st. Those of coarser threads,

(1) where these form a maze;

(2) where they produce straight axes usually with terminal (or initial) knobs;

2nd, the finer pattern,

(3) consisting of concentric or wave-lines;

(4) forming feathery or fan-shaped tufts;

3rd (5) vesicular structures, including rounded vesicles, or tapering canals;

4th (6) contraction structures, cracks.

This classification is somewhat artificial and intended to indicate the chief types, between which gradations may be found; and by combination and aggregation of different forms numerous varieties arise, as may be seen in the few figures reproduced.

3. *Conditions and Causes of Formation.*

It is not always easy to describe concisely the exact conditions that govern the formations since they include at least three variables. First, the nature of the material, its specific gravity, adhesive character, and the size of the grains; second, the relative amount of the material, *i.e.* the muddiness of the fluid mass; third, the form of the area occupied and the direction of retreat during subsequent drying. As an example of the influence of the last-named condition: in one case, when indigo was carried in by a current, the coarser particles were deposited over a triangular or semicircular area, while the finer material spread over the whole space.* Further, any pressure or force acting upon the mass during drying may influence the form assumed; thus bubbles sometimes exercise a resistance on the part surrounding.†

Materials which consist of grains too large and heavy to be easily moved may give rise to a rude attempt at a pattern. Thus, ordinary fine sand exhibited a dendritic form, a deep channel or gutter extend-

* The corner of the cover-glass was propped up with a few bristles.

† Included bubbles sometimes are surrounded by concentric bands of the finer material, as if the bubble favoured a uniform evaporation.

ing as an axis, and shallower narrower furrows forming the branches.

In materials which consist of very finely divided particles, the variation in the size of the grains is too slight to produce any effect and the result is a uniform pattern. Thus indigo generally forms a typical example of a maze. If, however, the material is smooth and oily, like gamboge, it is very slow in drying, and the general form which it assumes is that of knobbed straight axes.

In powders of medium grain the difference in the size of the particles causes marked effects (*e.g.*, chalk, prussian blue, sepia, &c.) If the mud is dense, drying uniformly, a mazy network is usually formed. A thinner mixture may produce knobbed straight axes. An intermediate condition in the drying mass gives rise to feathery or fan shapes, or to parallel generally curving bars.

The mode of formation can be understood by tracing successive stages, and by comparing different examples. When the water begins to evaporate, the retreating edge of the film drags back the coarser particles, leaving behind some of the finer material in a moist condition. This afterwards dries, not however quite uniformly, so that it is ranged in wave-like lines, between which clear spaces or uniform thinner material may intervene. If the boundary is wide the lines will be almost straight, if the margin is narrow they will curve with smaller radius. The film of finer material, after retreating, sometimes advances again in a slightly different direction as was seen in watching it, and two sets of curving lines are thus formed, which partly cross one another.

Meanwhile as the thick film retreats, its rim becomes concave between certain points. Then the boundaries of adjacent concavities approach, and in this way the intervening material is gradually reduced to a streak. Inequalities, however, exist within the film, and, where coarser grains occur, or a clot adheres closer to the glass, these scrape away the finer material, thus clearing paths and leaving intervening streaks, which are radial, often curved and transverse to wave-lines. The clearer furrows may terminate at a knot of coarser grains, when the force no longer suffices to move these back, so that they remain isolated or form the initial knob of a thick stem. This may extend as a straight axis, or, if the film of air broadens as it indents and pushes back the muddy fluid, the curving margin may form the beginning of a maze or network, such as was described above.

Between the thick axes fine stuff is distributed on similar principles to those which caused the forms near the edge. The two dominant structures are the nearly parallel or concentric wave-lines and the radial streaks. But in this case the finer material is deposited within limited areas by which the forms are modified. If

the wave-lines only are strongly marked, they may extend as curving transverse bars; if the radial streaks are the dominant feature they form radiating curves or feathery or fan structures. A thick mass in its final desiccation may show cracking like the hexagonal flakes of mud at the edge of a pond, or the thick axes of a slowly drying material (like vermilion) may be jointed transversely. Sometimes stellate cracks may form within a mass, as in the example already described (fig. 4).

4. *Possible Applications.*

We have now to consider the possible applications of these simple experiments to structures which occur in Nature. Water, carrying fine suspended material, will often penetrate into rocks along a plane of discontinuity, and drying may then give rise to a "pattern." *

1stly. Dendritic forms upon joint or other surfaces are generally regarded as the results of crystallisation, and this undoubtedly is often the case, as frost spreads on a window pane. But if the formation takes place under the constraint of a narrow space, it may be caused simply by desiccation in the way described above. It will not be easy in all cases to infer which has been the exact mode of origin; sometimes the angle at which the branches diverge in the dendritic structure will prove that the formation was governed by crystallising forces; but it is clear that both conditions often may co-operate.†

2ndly. If no cavity exists along the plane of weakness, and the coarser axes are adherent and imbedded within the mass, they might appear to represent tubular structures—to be, as it were, flattened cylinders. In course of time the molecular and the mineral character might be changed, and crystallisation even might take place either in the original or the replacing substance. Is it not possible that this may be the explanation of certain puzzling structures sometimes placed as doubtfully organic, such as some of the so-called "fucoid" markings, or the peculiar forms in certain limestones? ‡

3rdly. These last speculations lead us to consider the possibility of similar contractions taking place in space of three dimensions, as we may call it, instead of two—in the mass of a rock, instead of along its surface. Thus the principle governing the formation of the landscape marble, as described by Mr. B. Thompson,§ presents some

* In some experiments I used surfaces of rock, and obtained results on a slab of London clay, of slate, &c., only, as might be anticipated, the forms were coarser and less regular than on smooth glass.

† See note by Professor Bonney appended.

‡ This is not intended to refer to the Girvanella forms described by Mr. Wethered ('Quart. Journ. Geol. Soc.,' 1890 to 1895, vol. 46, p. 270; vol. 47, p. 550; vol. 48, p. 377; vol. 49, p. 236; vol. 51, p. 196) nor of necessity to Eozoon.

§ 'Quart. Journ. Geol. Soc.,' 1894, vol. 50, pp. 393—410.

similarity, although there it is the rise of gas hindered by material instead of the lateral spread of air, causing the retreat of the water-film which opposes it. Many peculiar forms assumed by concretions may be similarly explained.

The deposit of an opaline layer with cusped points around a cavity might be caused by the uniform drying of a smooth, homogeneous material. Modified by crystallisation, it might help in the formation of agates and chalcedonic deposits.*

Igneous rocks have formed from a molten mass which may generally be considered (as pointed out by Lagorio) like a solution of the less fusible in the more fusible constituents, or in some cases may consist actually of two magmas imperfectly mixed. As it becomes solid the two parts may mutually react in a manner analogous to the phenomena already discussed. The forms shown in the secondary silicification of certain rocks (*e.g.*, cherts, silicified rhyolites, &c.) perhaps afford another illustration. Though this process is not exactly comparable with the deposits of sediment described above, yet colloid silica might penetrate in different directions, and encountering constant obstacles, give rise to an irregular, almost felsitic structure.

4thly. In the specimens which show cracking and expansion of cracks to canals† or bubbles, we may see a resemblance to other forms in igneous rocks (fig. 4). Some of the stellate or cruciform cracks remind us of the kind of contraction which, in a semi-solidified pyromeride, develops fissures and inlets, afterwards filled by chalcedonic or other deposits. Further, the grouping of cracks and bubbles in the drying film of mud, imitating roughly some of those found within spherulites, would suggest that in certain of these a crust may be formed before their complete development. This would accord with the view which Professor Bonney has often advanced, in conversation with me, for certain Boulay Bay pyromerides,‡ and with the hypothesis which seemed to be suggested by certain Welsh pyromerides and variolites: § that the spherulite sometimes follows, as it were, an initial formation of a nodule which has arisen by flow-brecciation, or other process.

Thus it seems possible that in several points the simple forms I

* A comparison similar to that with the landscape marble might be made with the process for the artificial formation of agates described by Messrs. J. I'Anson and E. A. Pankhurst, 'Min. Mag.,' 1882, vol. 5, p. 34.

† Compare with these the branched canals in gelatin described by Professor Sollas, as due to the formation of ice spicules ('Trans. Roy. Irish Acad.,' 1890, vol. 29, p. 427).

‡ I believe that this view has the support of Mr. J. Parkinson, F.G.S., but I leave the sentence as it was written about two years ago (see 'Quart. Journ. Geol. Soc.,' 1898, vol. 54, p. 101).

§ 'Quart. Journ. Geol. Soc.,' 1889, vol. 45, p. 268; and 1893, vol. 49, p. 152.

have tried to record may help to throw light on certain structures and processes in rocks. Applying the principles we have noticed here, we might anticipate (even where crystallising materials are present)—

1stly. That mutual interactions may give rise to wriggling or mazy forms.

2ndly. That greater freedom of molecular motion might cause more rectilinear forms.

3rdly. That the relative ease of transmission in different substances or conditions of a substance may govern the forms developed, as the difference between the coarser and finer sediment.

4thly. That the form of the external boundary influences the structures developed, so that streaks normal to a rectilinear figure, or radial within a sphere, are caused.

5thly. That much depends on the relative permeability of the surrounding magma; and the solidification in a molten mass, first of an external crust, would act similarly to a more impenetrable environment.

Part II.

To have fully discussed experiments in which any effect of crystallising forces is shown would have unduly lengthened this paper, and on that subject some material has been published.* My main object is to call attention to the results of mere mechanical rearrangement, on which I think no distinct notice is available. But I may briefly refer to a few results of crystallisation. I experimented with solutions of various salts, mixed with gelatin, with "muds" of vermilion, &c., and in other combinations.

When solutions of calcium sulphate and of gelatin were mixed in varying proportions, if the solution was weak, crystallisation generally seemed to start at many scattered points. At these there formed small crystals or ovoid grains (like potato starch-grains, often compound) or clusters, frequently spherulitic. In the intervals was a gelatinous-looking deposit, which had no effect on polarised light.

* H. Vater, in 'Zeits. für Kryst. und Min.,' 1892–6, vol. 21, p. 433; vol. 22, p. 209; vol. 24, p. 366; vol. 27, p. 477. O. Lehmann, in 'Zeits. für Kryst. und Min.,' 1877, vol. 1, p. 453. 'Quart. Journ. Micr. Sc.,' 1855, vol. 3, p. 179, Pl. 13, 14; and 1856, vol. 4, p. 203, Pl. 12, by J. Glaisher; vol. 4, p. 201, by J. Spencer; 1861, vol. 1, n.s., p. 23, by G. Rainey; 1862, vol. 2, p. 128, by T. Davies; 1866, vol. 6, p. 137, by R. Thomas; 1872, vol. 12, p. 118, by Professor Harting. 'Roy. Soc. Proc.,' 1866, vol. 15, p. 314, by E. Montgomery. 'Trans. Brit. Assoc., 1867, p. 127, by Dr. Heaton. 'Phil. Mag., 1878, vol. 6, p. 113, by F. Guthrie. 'Intellectual Observer, 1865, vol. 6, by H. N. Draper. 'Trans. Roy. Micr. Soc.,' 1871, p. 50, by H. S. Slack. 'On the Influence of Colloids upon Crystalline Form, &c.,' by Dr. W. M. Ord, 1879. 'Nature,' 1892, vol. 47, p. 162, by Dr. J. H. Gladstone.

As we add a larger amount of the salt solution, the following effects were produced: first, the crystallised bodies all became larger; more crystal-shaped grains formed, instead of the rounded blebs,* and then, beyond an irregular, clear space around each, the ground was occupied by a more distinctly dendritic deposit, which faintly depolarised. In a more watery medium, the ovoid grains are more marked. From a mixture of vermilion in a solution of the salt, the results are similar, but the vermilion is in clots or lumps, or scattered granules, with intervening, irregularly shaped spaces. In one slide the clear spaces are rather definitely shaped and angular, almost as if dominated by crystallising force, yet the crystallising salt has formed only small, ovoid grains, clustered rather more thickly near the central part of the space.

The formation of spherulitic structures has been described by several authors. Good examples were obtained in these experiments with sodium phosphate mixed with gelatin. A weak solution, or a solution of the salt without the gelatin, gave spherulitic structures, though these were small and scattered. From a stronger mixed solution the deposit consisted of rounded, gelatinous-looking globules, more or less aggregated, which, with crossed nicols, showed radiate structure and a black cross. Radial tufts of acicular crystals of calcium sulphate are well known among microchemical tests;† these were obtained from pure solutions of the salt, or from mixtures with "mud," or with gelatin. One small isolated drop ($\frac{1}{8}$ inch across) of a mixture of calcium sulphate solution and vermilion, which dried on another slide,‡ exhibited spherulitic spheres or hemispheres (their centres being on, or just within, the circumference of the drop), clustered like those which have been obtained in a sheet of glass which had been raised to a high temperature and then cooled.§

In other drops, where definite crystals were formed, the crystals projected inwards, often with branched, almost dendritic, or skeleton, growth.|| If in certain spherulites a radial ingrowth of crystallites takes place, as seems probable, it would be somewhat analogous to this result of shrinkage or skin tension in the drop.

In certain examples, where a rather concentrated solution was

* *Cf.* H. Vater, 'Zeits. für Kryst.,' vol. 27, p. 489.

† "Notes on the Micro-chemical Analysis of Rock-making Minerals," by Lieut.-General C. A. McMahon, F.G.S. ('Min. Mag.,' vol. 10, p. 110). 'Manual of Micro-Chem. Anal.,' Professor H. Behrens, p. 71.

‡ I failed to reproduce this structure again, although many variations in the conditions were tried.

§ "Address of President," by Professor T. G. Bonney, 'Quart. Journ. Geol. Soc.,' 1885, vol. 41. p. 63. 'Roy. Soc. Proc.,' 1885, vol. 39, p. 103, by D. Hermann and F. Rutley.

|| For the mode of growth and general form of the crystals, compare Lehmann in 'Zeits. für Kryst.,' 1877, vol. 1, Pl. 21, figs. 49, 50*a* Pl. 22, fig. 84.

mixed with material in suspension (*e.g.*, calcium sulphate and vermilion), a mass of crystalline grains, separated by clear, narrow interspaces, occupy a definitely crystal-shaped area. The neighbouring grains are related in form, the spaces between are bent or curved, the whole resembling micropegmatitic or pegmatitic structure (fig. 5.)

In the formation of chiastolite and other secondary minerals, the matrix is often partly included, but in these experiments the more fluid medium apparently separated from the vermilion, thrust it to the edge of an initial, crystal-shaped area, and within that formed crystalline grains separated by interspaces. The grains generally depolarise uniformly, but occasionally are built up of clustered prisms, and sometimes even of slender, tufted needles. Lehmann, in his classic paper, describes the causes of irregular, or interrupted growth as due mainly to the viscosity of the medium or the presence of foreign substance * He points to spherulitic and dendritic forms as results. The micropegmatite seems to be one more possible development.† This would agree with the hypothesis advanced by Professor Bonney, that it results in igneous rocks, when the magma is kept at a somewhat persistent, but not too high, temperature; so that the material probably would be in a very viscous or partly solidified condition.‡

While this paper was in progress, I received from Professor Bonney the following interesting note (drawn up by him some years ago),§ the more valuable as made upon one of nature's experiments. The observation adds one more suggestion as to the possible formation of "pseud-organic" structures, that they might originate from a mixture of mechanical sediment and of a crystallising salt, and the forms in the mud might remain even if the salt were afterwards dissolved.

The note is as follows:—" In walking along the pavements during the late frost, before the sun or the feet of the public had produced an effect, I was often struck with the forms of the ice crystals. The pavements were dirty; much fine mud, brought from the roads on the boots of pedestrians, had been pretty evenly distributed in a thin film. During the night this had been arranged in rod-like crystals, often 3 or 4 inches long. These formed groups, spreading like the sticks of a partly opened fan. They were sometimes

* 'Zeits. für Kryst.,' 1877, vol. 1, p. 453.

† Micropegmatite is closely related to the other forms.

‡ "On a Contact Structure in the Syenite of Bradgate Park," 'Quart. Journ. Geol. Soc.,' 1891, vol. 47, p. 107.

§ Of this note, written in December, 1892, an abstract was sent to 'Nature' (December 15, 1892) by the author in corroboration of a letter, which had appeared the previous week, from Professor Meldola, calling attention to the same phenomenon. Several letters (from Dr. J. H. Gladstone and others) on the same subject were printed at the same time. 'Nature,' vol. 47, pp. 125, 162.

slightly curved,* perhaps about $\frac{1}{9}$ inch in diameter, and $\frac{1}{8}$ inch at thickest. They differed from the 'frost ferns,' in a much greater simplicity of structure, being more like little bunches of grass arranged along a stem than those exquisite and intricate fabrics of the ice-world. They reminded me sometimes of the groups of actinolite crystals in certain crystalline schists, as for instance at the St. Gothard. These actinolites, on examination under the microscope, prove to be not pure crystals, but much interspersed with granules of pre-existing minerals. It occurred to me that the probable reason for the formation of these ice structures was the impediment offered by the small grains in the mud to the growth of tiny crystals. Only here and there, where circumstances were exceptionally favourable, a crystal larger than usual would be developed, which, as it advanced, gathered to itself other crystalline molecules. Thus would be started a bunch of coarse crystals, springing from a common centre, growing more easily in the direction of the axis of the rhombohedron, just as in the case of frost ferns, but they would be simpler, coarser, and arrested by the impediments, instead of delicately flexured by the almost imperceptible inequalities of the glass.

"I obtained on a later morning, strong confirmation of this view. Heavy rain fell all through the preceding day, followed by a clear night, with a ground-frost. In many places the pavements had been washed very clean. On the *clean* paving stones I saw, not unfrequently, early the next morning, fairly delicate frost ferns (though not equal to those on glass). Where the surface had been a little dirty, the forms were less intricate and coarser; in some rather dirty places the old types could be seen.

"*Postscript.*—What is written here was my impression at the time, but I have since doubted whether the crystals were not 'muddier' than the part around. It was not possible to examine the pavement very closely; also I noticed on a later occasion that the trampling of the film of mud (prior to freezing), which produced a kind of concentration in an irregular network of wavy lines or bands, appeared to have something to do with the formation of the flowers."

This note suggests that analogous processes may be traced in schists, like those of the St. Gothard, and the mode of formation of certain crystals in schists has been described in papers already published.† On this point, however, it is needless to enlarge, as we may hope to receive more results, since Professor Bonney has communicated a paper dealing with this subject to the Geological Society.

* Similar forms were noticed on certain days in the winter, 1896–7.

† "On a Secondary Development of Biotite and of Hornblende in Crystalline Schists from the Binnenthal," by Professor T. G. Bonney, 'Quart. Journ. Geol. Soc.,' 1893, vol. 49, p. 104. Also "On some Schistose Greenstones, &c.," by the same author, *ibid.*, p. 94.

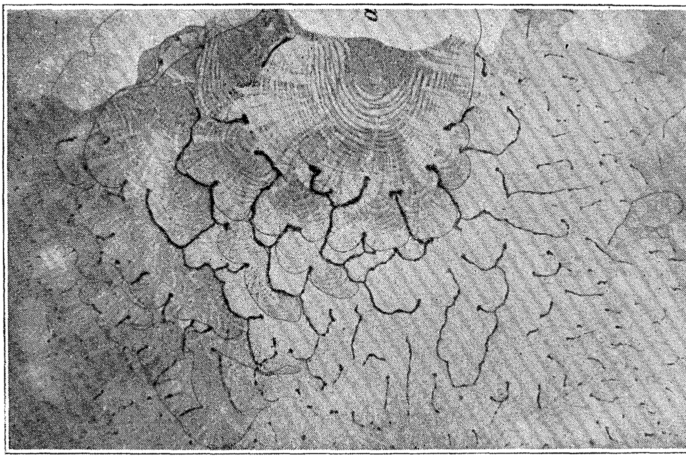


FIG. 3.

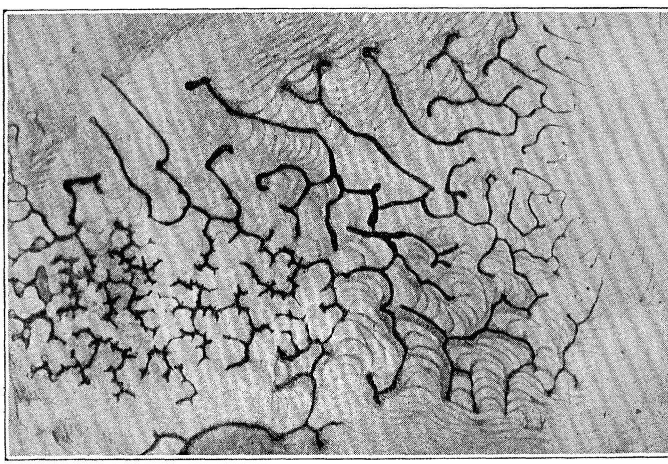


FIG. 2.

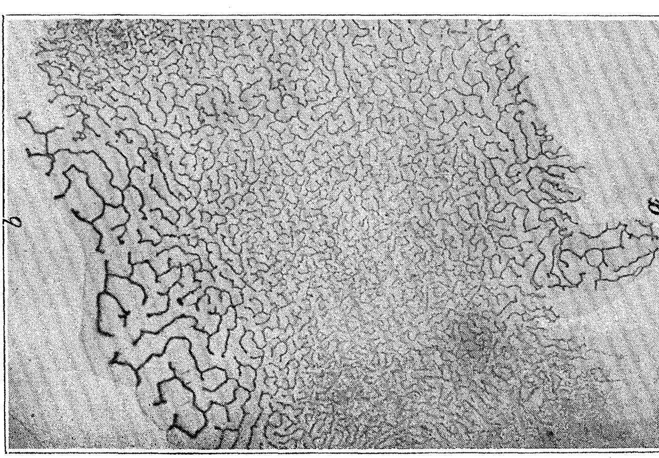


FIG. 1.

Fig. 4.

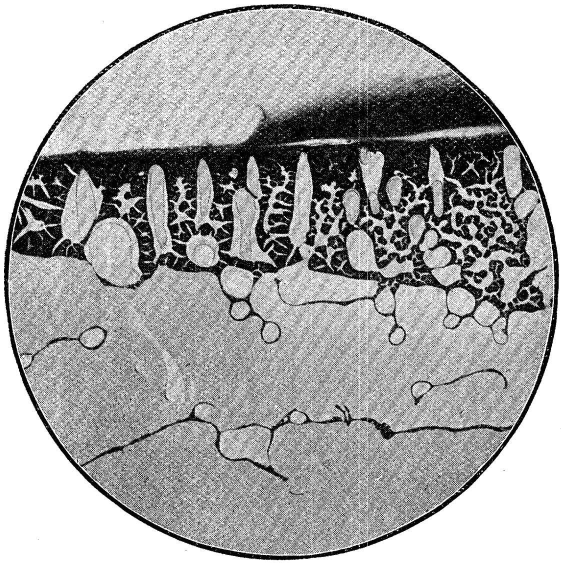
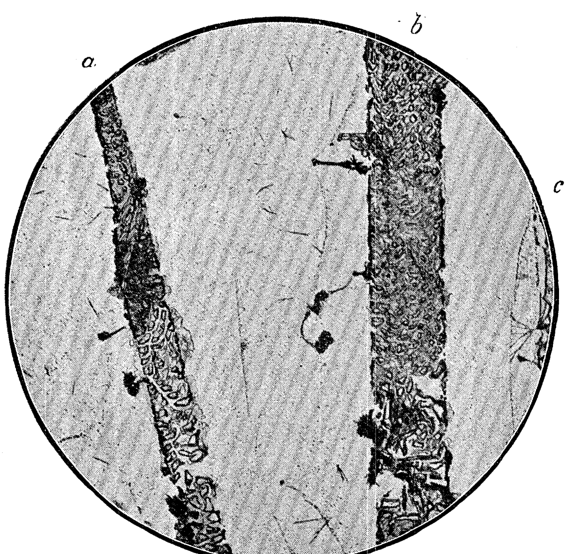


Fig. 5.



EXPLANATION OF FIGURES (PLATE 2).

The results shown in figs 1—4 were obtained on glass plates, about 6 inches by 3 inches, with cover-glasses about 3 inches by 2 inches. The whole pattern is represented in figs. 1—3, but fig. 4 shows a small part only of one slide (magnified). In each experiment a drop of the mud was placed on the slide, and then covered, so that the mud spread out somewhat irregularly. In other examples similar results were obtained, after running in material or keeping up a current for a short time to carry the mud along.

FIG. 1.

Prussian blue in water. This was placed on the glass as a large drop, and a very small one was accidentally deposited near by, in which the pattern at *a* has been developed. The mud in a few minutes began to show indication of the future pattern. Very shortly the film retreated from two edges (*a* and *b*), where the mud was "denser," and where it dried to a coarse maze. Afterwards the fine maze formed, and was completely developed in two or three days.

FIG. 2.

Chalk mass, somewhat thin; tilted so that the cloudy chalk gradually flowed down. In this pattern the rods tend to become straighter, connected by curved transverse bars.

(A pattern from denser chalk in several cases, not figured, was that of a coarse maze.)

FIG. 3.

Prussian blue. The fine pattern near one edge (*a*) with concentric or wave-lines, and some clearer radial furrows was first developed. Then coarser bent stems were deposited, and towards the further margin these became smaller, interrupted, and finally reduced to isolated spots, while the fine material formed rather feathery tufts (less distinct in the photograph). Dried in about two days.

FIG. 4 (× 8 diameters).

From a large slide of vandyke brown, which formed straight axes and a fine "wave" pattern (an indication of this is shown at one side of the figure). Part of the edge "caked" in drying, and within it, bubbles developed, often elongated transverse to the margin, and stellate cracks or series of cracks. Fine material, somewhat faintly marked in the figure, has formed roughly oval-shaped patches in the vesicles or a central streak in the cracks.

Note.—Certain sharp lines, partly overlapping the pattern in figs. 3 and 4, mark the edge of a film of canada balsam, by which the cover was sealed down.

FIG. 5 (× 25 diameters).

Mixture of a solution of calcium sulphate and vermilion dried on an ordinary microscope slide beneath a cover-glass.

The figure represents parts of two long skeleton crystals of calcium sulphate (*a* and *b*) in which a micropegmatitic structure has formed. A small part of a third crystal (*c*) is shown, the substance of which extends more continuously. The vermilion partly borders the edges of the large skeleton crystals, and is black and opaque in the figure. Other black patches in it are composed of aggregated crystallites of calcium sulphate with some vermilion. The fine scattered lines or radial tufts are similar crystalline needles of the salt.

FIG. 1.

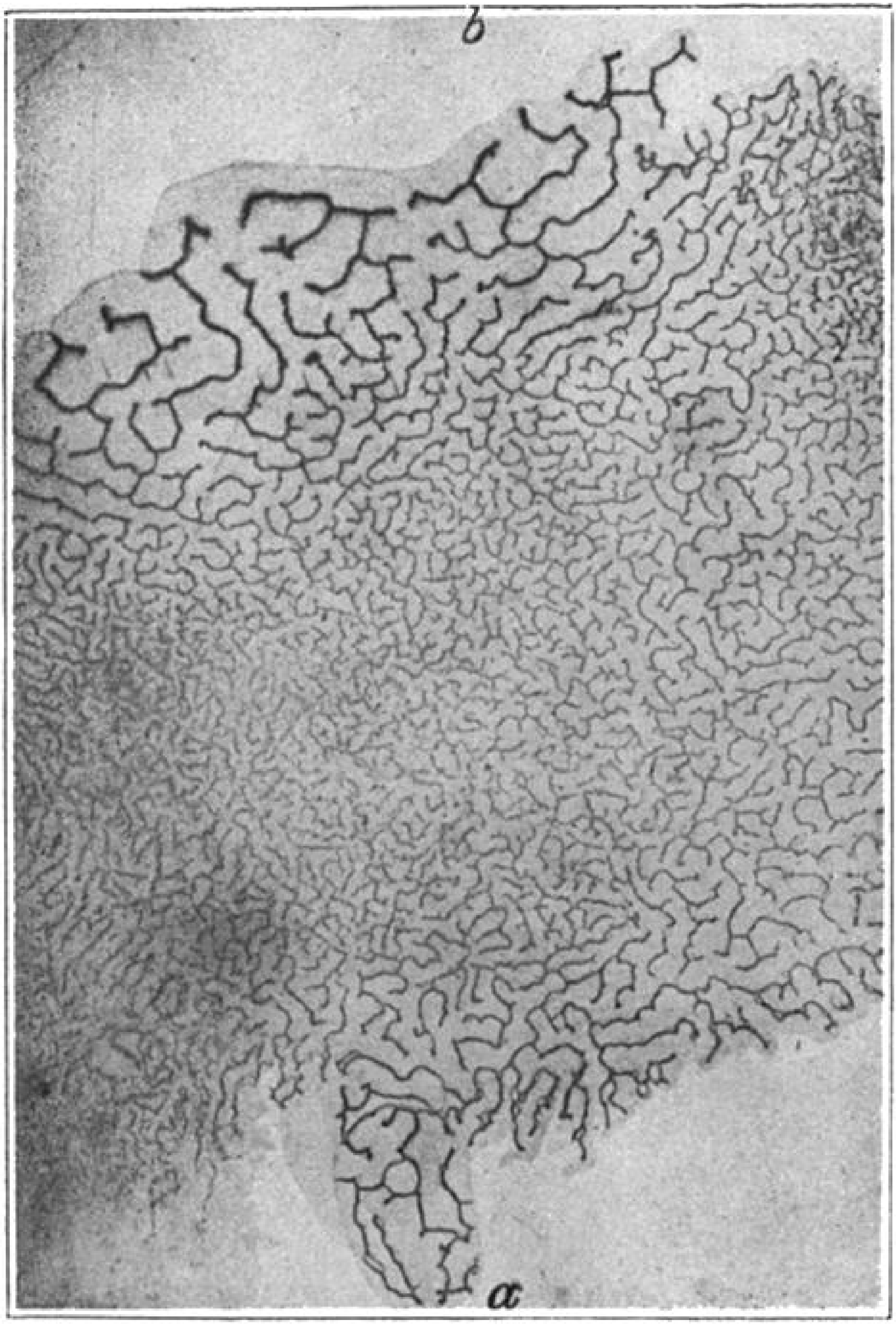


Fig. 2.

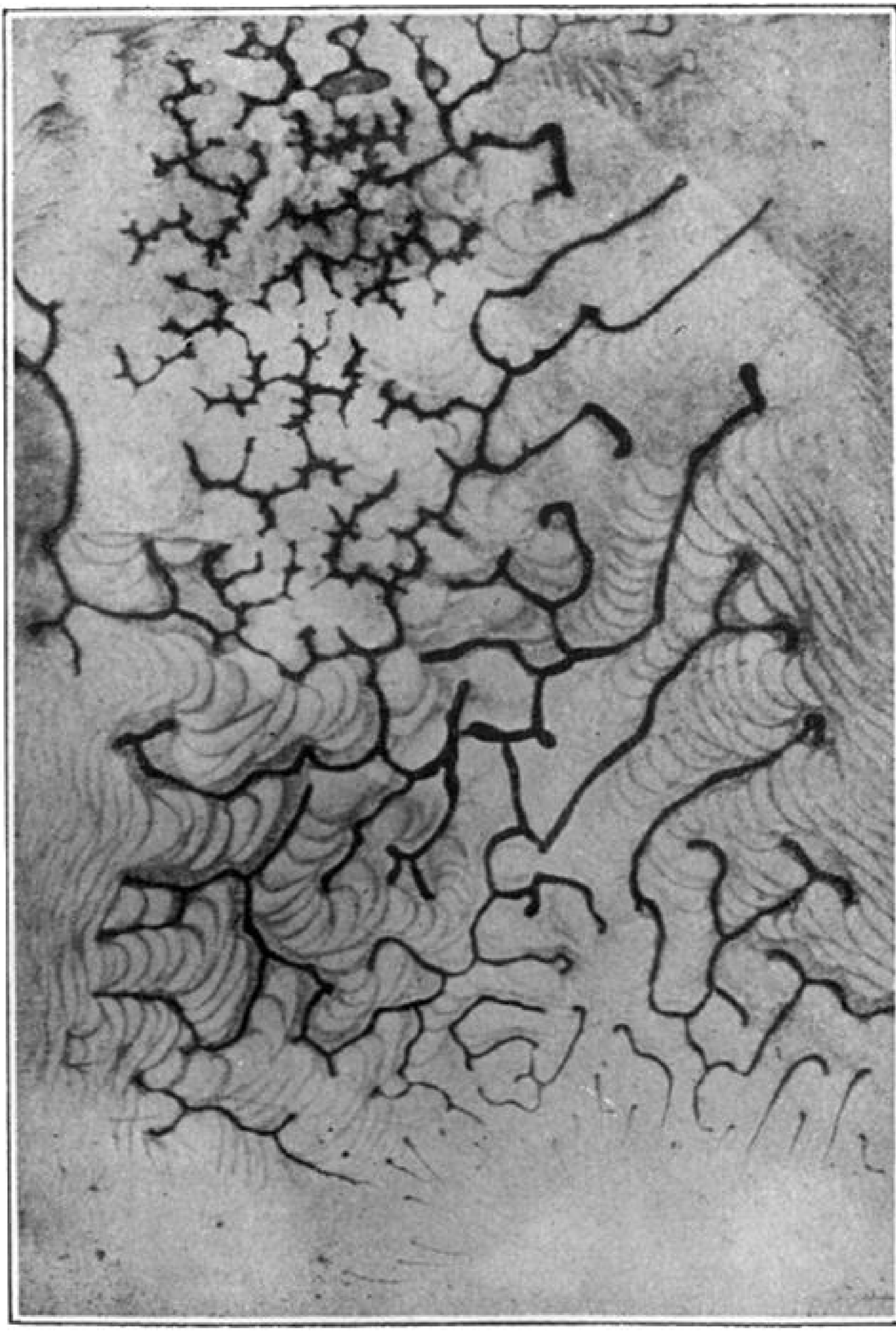


Fig. 3.

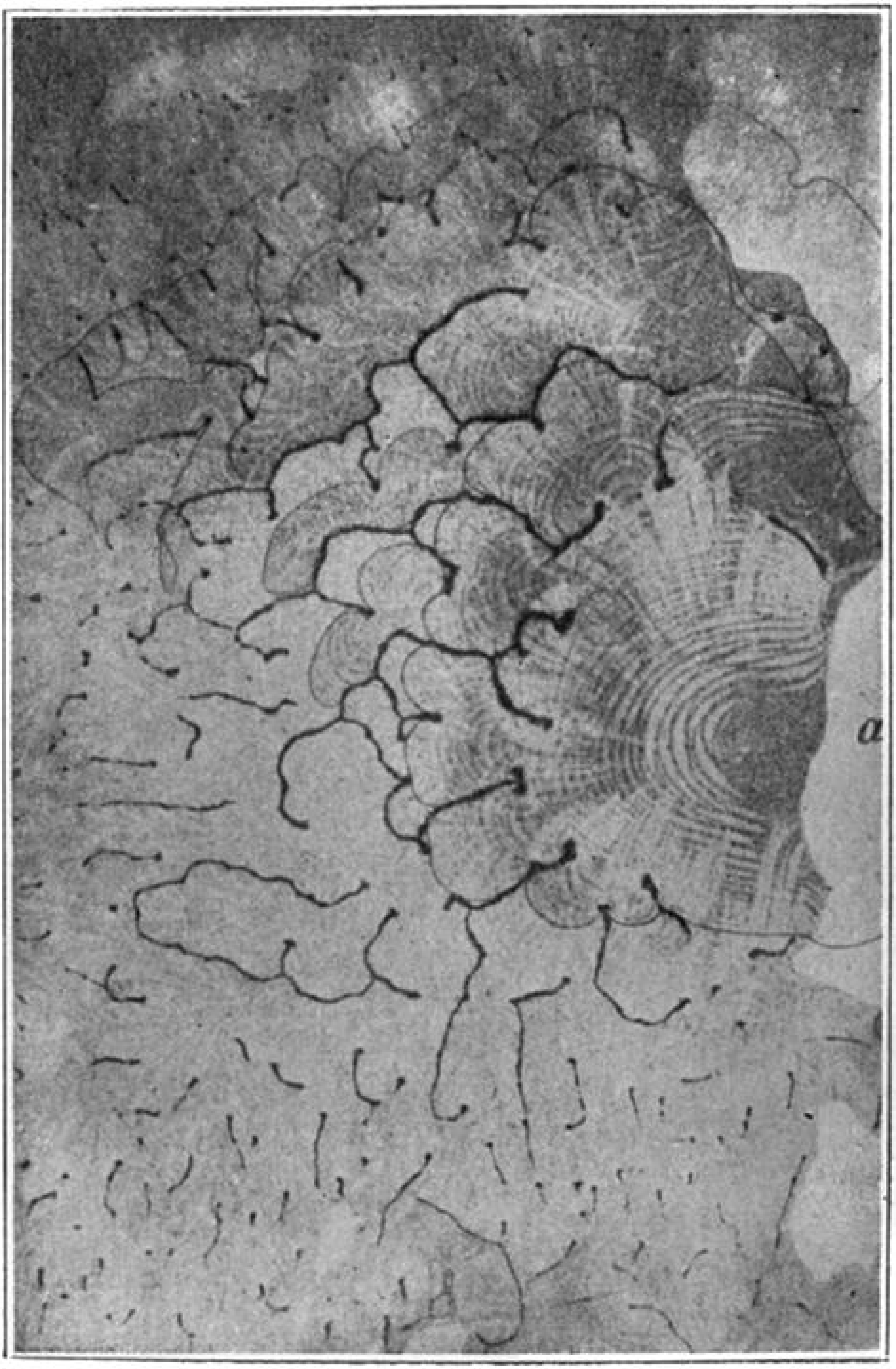


Fig. 4.

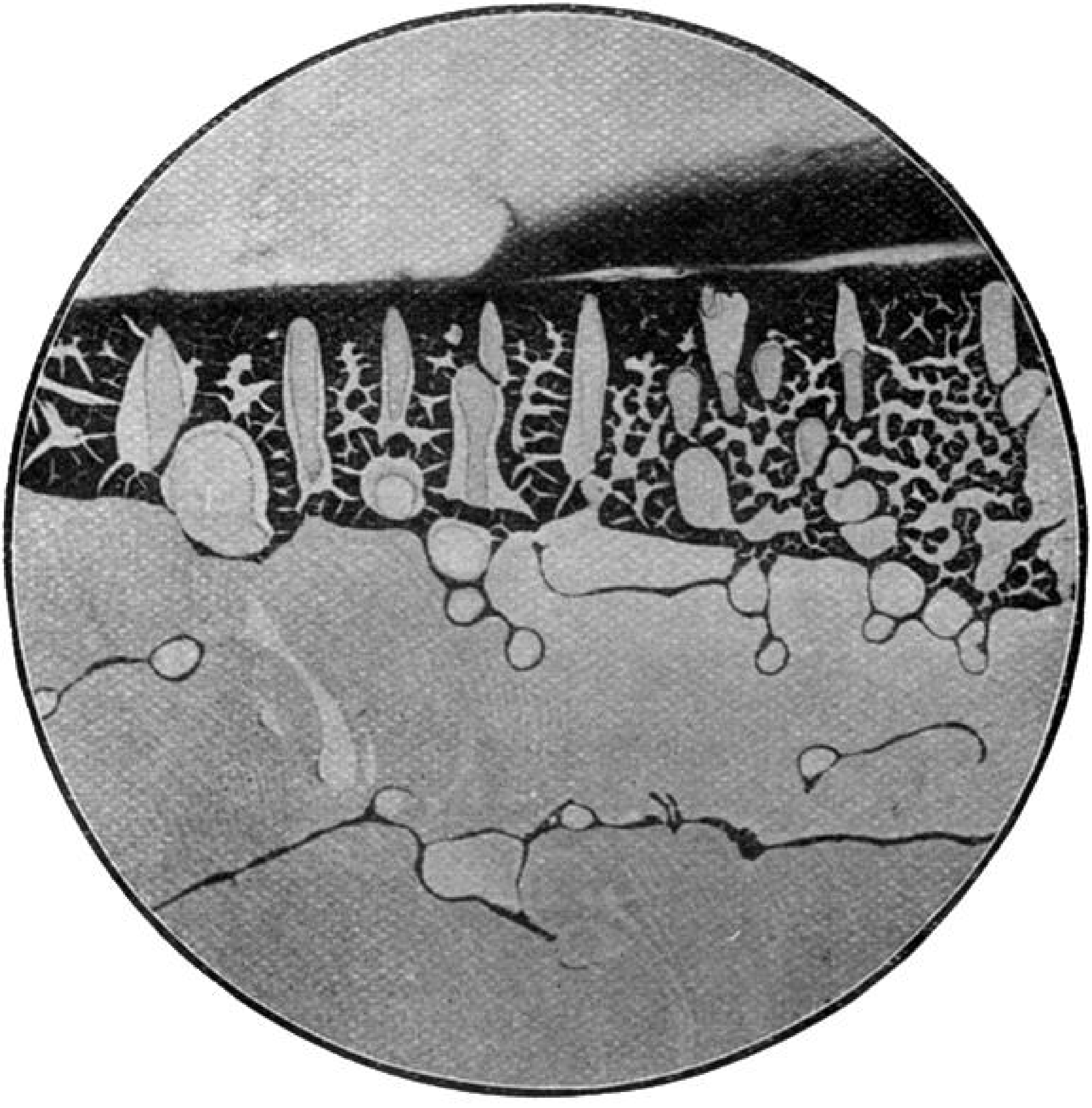


FIG. 5.