A new method for the preparation of thin sections of clays.

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THIN sections of clays are not easily prepared by the routine petrographic methods. The chief difficulties are due to the extremely fine texture of the clays and to the soft and plastic nature of these materials. These difficulties are only too well known, and, although in some cases they have been partially overcome by impregnation *in vacuo*, it is safe to assume that really little work has been accomplished in the microscopic examination of clays on account of the difficulty of producing satisfactory thin sections. The writer has attempted to extend the scope of the microscopic investigation of clay rocks by means of the technique outlined below.

The method has been devised in response to an appeal by a friend, who, working in a laboratory at a well-known pottery works and thus connected with the clay industry, desired a method that would make possible the examination of thin sections of clays under high powers with polarized light. The writer claims that this has been achieved, and the method permits the use of oil-immersion objectives at a magnification of 1000 or more. It will be seen below that a number of clays respond to this method, with one notable exception. Fuller's earth has so far resisted attempts in the production of a useful preparation.

Technique.—This method of preparing thin sections of clays is a modification of the principles used for preparing cellulose 'peels' of fossil plants. These petrifications, which may be either calcareous or siliceous, are cut in a rock-slitting machine, and after the cut surface has been smoothed on the fine grinding plate, it is then etched with hydrochloric or hydrofluoric acid, whichever the case may be. When dry the etched surface is covered with pyroxylin, and the latter, when hardened by evaporation of the amyl acetate, can be pulled off as a film.

This principle is employed for the treatment of clays, with the exception that no etching with an acid is necessary, for it is essential that the clays should be in a perfectly dry condition.

Preparing the specimen.—The clay sample must be prepared and a smoothed surface obtained to receive the pyroxylin. Obviously the routine method of wet grinding is impracticable, as the clay will immediately become plastic. Abrasive powders cannot be used, as coarse carborundum tears the surface of the specimen, and the fine powders inevitably lead to contamination.

To obtain the prepared surface, therefore, the clay must be ground on dry glass plates without the use of abrasives. These grinding plates (a convenient size is 12 inches square) are prepared by grinding with coarse (90), medium (220), and fine (600) grades of carborundum powders, and when thoroughly washed and dried they are ready for use. The coarse plate may be used for rapid smoothing, but the medium and fine plates must be used for obtaining the finished surface: the selection of the finishing plate is determined by the nature of the clay under treatment as explained below. Preliminary paring can often be achieved with a sharp razor blade. If the clay is extremely fine textured, the best result is obtained by finishing on the medium plate; in other cases the fine plate yields a suitable finish.

The grinding operation, carried out by a circular motion with little or moderate pressure, is begun at the centre of the plate and gradually carried outwards towards the sides, so that as the roughened surface of the plate is gradually choked up with clay powder, fresh areas are progressively used. The specimen must be carefully brushed before proceeding from the coarse to the fine plate. If necessary an additional 'polish' can be obtained by gently rubbing the specimen on a piece of good quality glazed notepaper, taking care to brush well afterwards. The plates must be thoroughly washed when one sample is finished and before commencing on another.

When the grinding operation is completed, the specimen is arranged on a pedestal of plasticine to ensure that the prepared surface is level; it is then ready to receive the pyroxylin.

The pyroxylin as used for the treatment of fossil plants is a very thick viscous solution, but when used for clay rocks it is necessary to dilute it in equal proportions with amyl acetate, since it must be borne in mind that a very thin peel is desirable for examination under high-power objectives. Before applying the pyroxylin the surface of the clay is flooded with amyl acetate: a length of glass tubing drawn out to a small aperture will enable the requisite amount of amyl acetate to be applied. The amyl acetate is soon absorbed by the clay and then a small quantity of pyroxylin is spread over the specimen by means of a glass rod. When

the pyroxylin has spread evenly over the surface any air bubbles are pricked with a mounted needle, but care must be taken to avoid touching the now softened surface of the clay. The preparation is left for about five or six hours to dry, and by supporting a funnel over the specimen dust is prevented from settling down into the pyroxylin.

When dry the film is ready to be pulled off: to start the peel the point of a penknife is carefully inserted at the edge and carried along a short way, when the whole film can be gradually lifted away from the specimen. If on inspection the film appears a little too thick, the clay side of the film may be smoothed down on paper, but with practice this may not always be necessary.

Mounting the film.—The clay film has now to be mounted, and some difficulty may arise owing to the tendency for the film to curl with the clay side inwards, which increases when heated on the mounting plate. To prevent this it is placed upon the plate with the clay side downwards and held down with a heavy lead weight some $2 \times 2 \times 1$ inches in size.

It has been found that temperature control while cooking the balsam is the only way of making a successful and lasting mount of these films. Such control is obtained by the attachment of a thermometer to the mounting plate. The writer uses a copper plate $8 \times 5 \times \frac{3}{10}$ inches in size supported on a tripod. At one corner of the plate a brass cylinder is fitted. A well-fitting cork is bored to take a thermometer reading to 200° C. the stem of which is wrapped in a piece of copper foil 2 inches long and 1 inch wide. When the cork is fitted to the cylinder the bulb of the thermometer rests in a cup that has been drilled into the plate to receive it, which ensures good contact between the thermometer and the copper plate; the copper foil is adjusted so that it rests directly on the plate. The plate is heated by means of a bunsen burner which has a by-pass attachment and this is adjusted to keep the plate at a constant temperature of 45°, at which temperature the mounting of each film is commenced. To regulate the heating of the plate a screw-clip is fitted to the rubber tubing of the burner and is adjusted so that the temperature will gradually rise to 120° in 15 minutes. In this way a convenient temperature range is obtained and full control over the whole mounting process is possible.

Canada balsam is the mountant used, and for manipulating the clay film and cover slips, broad pointed forceps are an advantage; for adjusting and pressing down the cover glass a match stick, trimmed to a chisel edge, will be very useful and minimizes the danger of breaking the cover glass at the critical moment in the mounting process.

Procedure.—The clay film is first trimmed with scissors and placed, *clay side down*, on the mounting plate, which is at 45°, and pressed down with the lead weight for 15 minutes, or longer if possible, to ensure that

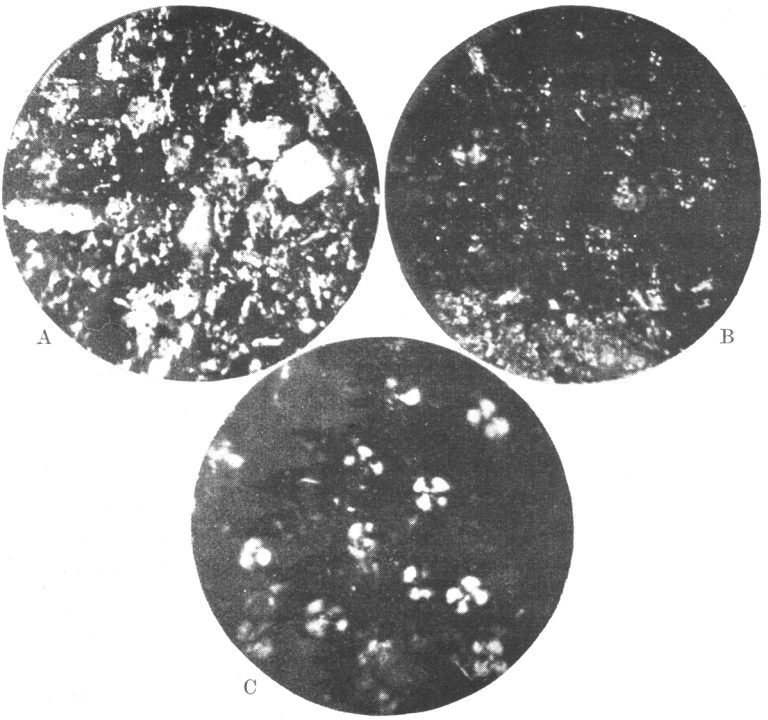

FIG. 1.

A. London clay. Showing detrital quartz grains set in a matrix of fine quartz particles and micaceous strands. Crossed nicols. × 200.

B. Speeton clay, Speeton, Yorks. Spherulitic matrix. The anisotropic patch at the bottom is made up of numerous spherulites. Crossed nicols. × 300.

C. Spherulites in Speeton clay. Each spherulite shows the characteristic 'mangle-wheel' cross. Crossed nicols. × 1000.

it is 'ironed out'. This will prevent the film from excessive curling when heated to a higher temperature in the Canada balsam. Meanwhile the 3 × 1 micro-slide and cover slip are cleaned and placed on the mounting plate.

The flame of the bunsen burner is turned up and at 60° the balsam is applied to the micro-slide and cover slip. When the balsam has spread out and all air bubbles have been pricked with a needle, the lead weight

is quickly removed, the film is *inverted* and immersed in the balsam on the 3×1 micro-slide. The film is then firmly but carefully pressed down with *clean* forceps to prevent it from floating up. At 75° the cover glass is lowered over the film and pressed down with a chisel edged match stick. The mount is kept on the hot plate until the thermometer registers 90°; it is then placed on an opal glass tile to cool; the excess of balsam is then cleaned off in the ordinary way with methylated spirit, and the mount is labelled ready for examination under the microscope.

The clay sections prepared and mounted as described above have obvious advantages, for the sections are easily prepared and the field for investigation is considerably widened.

These clay films, however, are not sections in the ordinary sense of the term, for examination under low powers in polarized light shows that the detrital quartz grains have been pulled out entire, as is evidenced by the fact that the central parts of the grains show higher polarization colours than at the edges.

But the chief point of interest in these films is that the matrix can be thoroughly explored under high-power objectives, and perhaps further information may be obtained by using this method than has been possible hitherto. The author has observed that some clays when examined between crossed nicols under high powers are seen to have a matrix composed almost entirely of spherulitic bodies, each of which shows a peculiar 'mangle-wheel' cross. In other clays these authigenic constituents are entirely absent. As far as can be ascertained these structures have not yet been recorded. Representatives of both types of clay are illustrated in Fig. 1 A–C, and indicate that future research is likely to yield further interesting results which may lead to conclusions of geological significance.

Successful preparations have been made from a number of clays, among which are the following: London clay, Eocene pipe clay, Barton clay, Speeton clay, Wadhurst clay, and Oxford clay. It is interesting to note that the method has been tried on coal samples with varying degrees of success, but it may be possible to make improvements at a later date. An excellent section has been prepared from chalk in which the writer has noted that the structures on the exterior of the foraminiferal tests can be easily studied.