A rapid method for the preparation of thin rock-sections.

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THE basic technique for preparing micro-thin rock-sections has altered little since this method of studying rocks was first accepted. Abrasive powders were, and still are, used either on glass or metal plates, the grinding being done entirely by hand. At the present time carborundum is almost universally used as the abrasive. The technique has been speeded up somewhat by the use of horizontal metal laps, and in more recent years the introduction of high-speed diamond-cutting and lapping apparatus has considerably reduced the time involved in making a thin rock-section. But even with this apparatus the process is still long and laborious, and, even more important, the operator must have considerable skill and experience in keeping the specimen whole and of uniform thickness throughout the entire operation.

The writer is responsible for supervising the preparation of all rock-sections, both for teaching and research purposes, in the Department of Geology, King's College, London. The difficulty has always been to keep the research worker supplied with sufficient sections to enable him to continue with his work. Using the existing technique of sectioning, including the use of high-speed cutting apparatus and horizontal rotary laps, the time spent in preparing a section from average material varies from half to one hour, friable material taking longer. This position made it desirable to look for mechanical and speedier methods of doing the rough grinding. Many previous attempts have been made to construct apparatus for this purpose. As far as can be traced all these methods have involved attachments to, and apparatus for use with, horizontal rotary laps. It is known that engineers in their work use surface-grinding apparatus involving vertical rotary grinding wheels, and their finished products have to be true to a thousandth part of an inch. It was with this knowledge in mind that the writer constructed a metal holder on which a 3×1 inch glass slide could be held flat and secure. Such a slide, with a prepared rock specimen cemented thereon (in the conventional manner), was inserted in the holder and this was then clamped on the table of a surface-grinding machine and an attempt was made to grind the specimen, using a wheel of 90 grit carborundum,

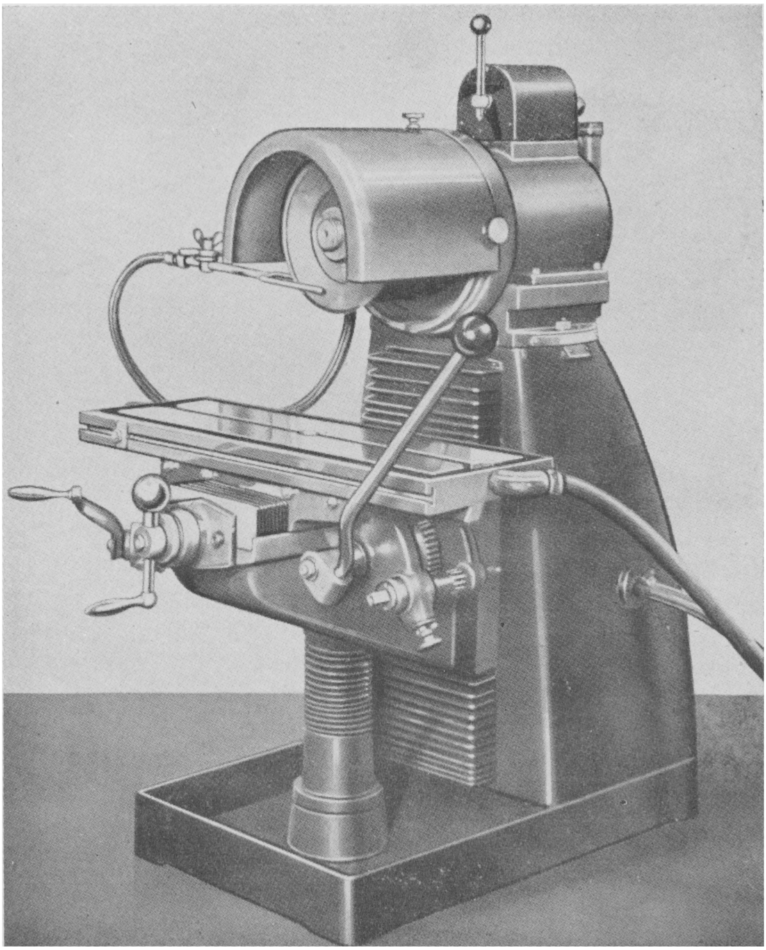

FIG. 1. The G.F.3 surface grinding machine. Overall height 31 inches; table space required 30 × 30 inches.

1 inch in width, rotating vertically at 2500 r.p.m. The result was disappointing. The wheel became hot at the point of contact and it was clear that the carborundum wheel was not suitable.

Using the same holder, a second attempt at surface grinding was made. This time a modern grinding machine, the G.F.3, was used. This machine, illustrated in fig. 1, was supplied by the Impregnated Diamond Products, Ltd., and is already in use in a number of geological departments as rock-cutting apparatus. It consists essentially of a diamond-impregnated grinding wheel held rigidly above a table and rotating vertically. The table is capable of being raised and lowered to and away from the wheel, and also of being moved horizontally towards or away from the operator across the width of the wheel, both these movements being adjustable to a thousandth part of an inch. The grinding operation itself is hand-controlled by a lever that enables the operator to move the table backwards and forwards in the direction in which the wheel rotates. This particular machine is also fitted with a magnetic table. The holder is placed on the table and when the magnet is switched on it is pulled down absolutely level and held quite rigid. The grinding is then carried out, using a diamond-impregnated wheel, grade 140–160, $\frac{5}{16}$ inch in width, rotating at 3000 r.p.m., the point of contact being cooled by a jet of weak soluble oil.

The first results achieved with this machine proved most encouraging, so further tests were made to grind a rock specimen of basic material down to a predetermined thickness of 0·004 inch. This was carried out by first raising the table until the wheel was in contact with the surface of the glass slide, and then lowering it by 0·004 inch. The rock-section was then ground. Upon examination it was found that although about 40 % of the section had been ground completely away, the remainder (normally grey polarizing minerals) showed first-order colours. This was obviously due to the uneven thickness of the balsam beneath the section, as the glass slide itself was unaffected. By experiment it was found that the simplest method of avoiding this uneven distribution of balsam was by grinding a channel about $\frac{3}{4}$ inch wide and 0·002 inch deep across the glass slide. This channel is filled with balsam and the specimen is then pressed firmly down on to the glass, the specimen, of course, overlapping the channel (fig. 2). This method also proves advantageous in that, as there is virtually no balsam between the glass and the section, the thickness of the specimen after primary grinding can be quickly ascertained by measuring the complete thickness of the slide and specimen, and deducting the known thickness of the slide.

A new holder, fig. 3, was now made to enable three specimens to be ground at a time, the glass slides being held in position by a knurled-headed screw at each end, the tips of the screws being protected by fibre heads. These heads ensure the screw gripping the glass, so that in practice it is only necessary to clamp down lightly. In order to facilitate examination under the microscope without removal from the holder, the latter was designed to fit on to the microscope stage, and holes were bored under the position of the centre of each specimen. The magnetic table ensures that the clamp is pulled down level again into the same position on replacement.

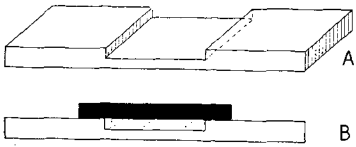

FIG. 2. A, 3×1 inch glass slide with channel ground to depth of 0·002 inch. B, The same in section showing the rock-slice overlapping the channel by approx. ¼ inch on each side. The channel has been exaggerated for illustrative purposes only.

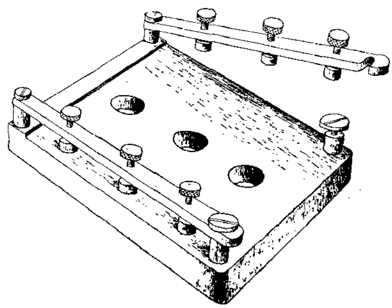

FIG. 3. The holder designed to hold three 3×1 inch slides during the grinding operation.

This method has been found entirely successful. It is possible to grind three sections at once, and grey polarizing minerals, such as quartz and felspar, show second-order colours (corresponding to a thickness of 60 microns) in a matter of two or three minutes, a uniform thickness, of course, being assured. The sections are then completed by hand, using the finest grade carborundum powder.

A variety of materials have been ground with equal success, including friable materials impregnated with shellac-balsam, dammar gum, and 'Lakeside 70'. It has been found that the wheel is much more efficient if it is kept well dressed back, this operation being carried out in a few moments during the grinding. The cleaning sticks used are cheap and obtainable from the makers of the machine.

It is essential that the 3×1 inch slides are of a uniform thickness all over. In practice it is a simple matter to check this thickness with a micrometer, and at the same time to grind out the channels. The slides are best dealt with in boxes of half a gross at a time, and the whole of the operation, including the checking of the thickness, can be completed in about half an hour.

During the grinding operation it sometimes happens that the ends of the glass slides become fractured. This presents no difficulty, however, as the section can be easily transferred by the following method. The writer normally transfers *all* finished sections. The surplus balsam is scraped away and the section is then carefully scrubbed (to remove abrasive grains), and lightly painted over with a solution of equal parts of amyl acetate and 'Durofix'. This dries in about thirty seconds and does not affect the refractive indices. It is then placed on an electrically heated hot plate (with a surface temperature of 100° F.) and a clean 3×1 inch slide placed beside it. Fresh balsam is applied to its surface and to the glass slide. When the balsam begins to run freely the section is gently moved over on to the glass with the mounting needle and the cover-slip is placed on in the usual manner. In the case of sections impregnated with 'Lakeside 70' it is necessary to turn the section over completely when transferring to the clean glass slide to release the air bubbles trapped on the under side, this operation being carried out with the aid of pointed forceps.

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