The Open University

McArthur Microscope Polarizing Version

Instructions for assembly and usage

IMPORTANT: Read these notes carefully before attempting to assemble or use the instrument.

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The polarizing version of the Open University McArthur Microscope is based on the standard version with the addition of an analyser and polarizer, together with a graduated rotating stage. (On conventional microscopes, the positions of analyser and polarizer are different from those on this instrument. This is simply a matter of design, but you should remember, if ever you use a conventional microscope, that normally the polarizer is between the light source and objective and is kept fixed, and the analyser is between objectives and eyepiece and is moveable.) The microscope is provided with a x5 eyepiece, and two objective lenses, x8 and x20, giving overall magnification of x40 and x100.

It is supplied together with a transformer to supply a steady current to the internal illuminating system, and a tripod to provide a firm base for the prolonged laboratory use that will be required for geological study.

This version is used to look at thin rock sections, 30 microns in thickness, under transmitted plane polarized or cross polarized light. With the polarizer and analyser (marked L and F in the photographs) OUT of the optical system, biological specimens can be viewed in normal light.

The compactness and low price of the polarizing version make it ideal for the geological work that is increasingly being undertaken in schools and technical colleges, as well as for undergraduate work in universities and polytechnics.

The McArthur polarizing microscope is a complex instrument and therefore these instructions should be read and followed carefully when assembling it.

The three labelled photographs on pages 3, 4 and 5 should be used in conjunction with the instructions.

Main components

The microscope together with its stage (G) and polarizer (L) (Fig. 1).

A tripod

A transformer together with the transformer leads—mains lead (A) and output lead (B) (Fig. 1).

The microscope assembly

(a) Optical System
A series of prisms directs the light from the bulb through the object slide, objective lenses, and polarizing components, and thence to the eyepiece (Fig. 4).

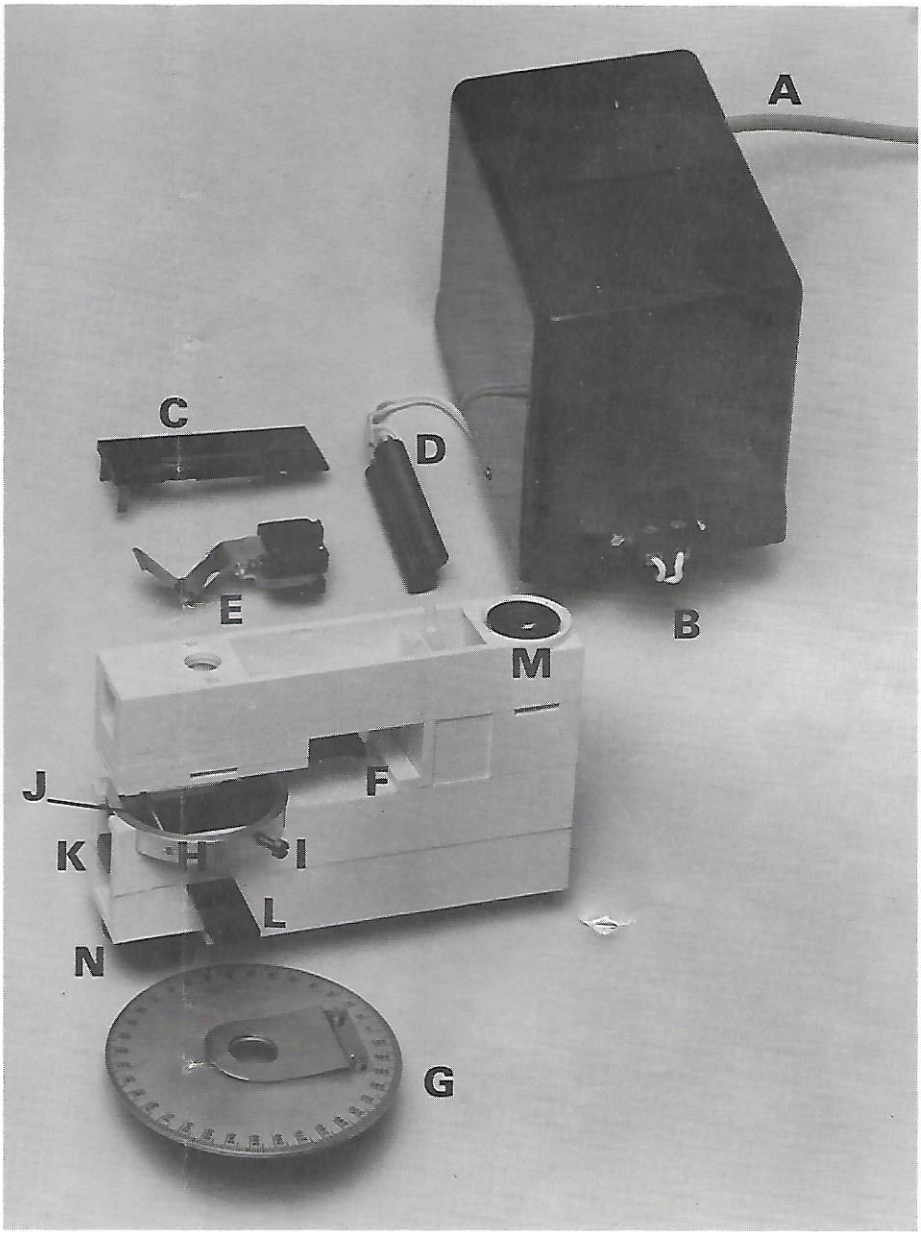

Figure 1

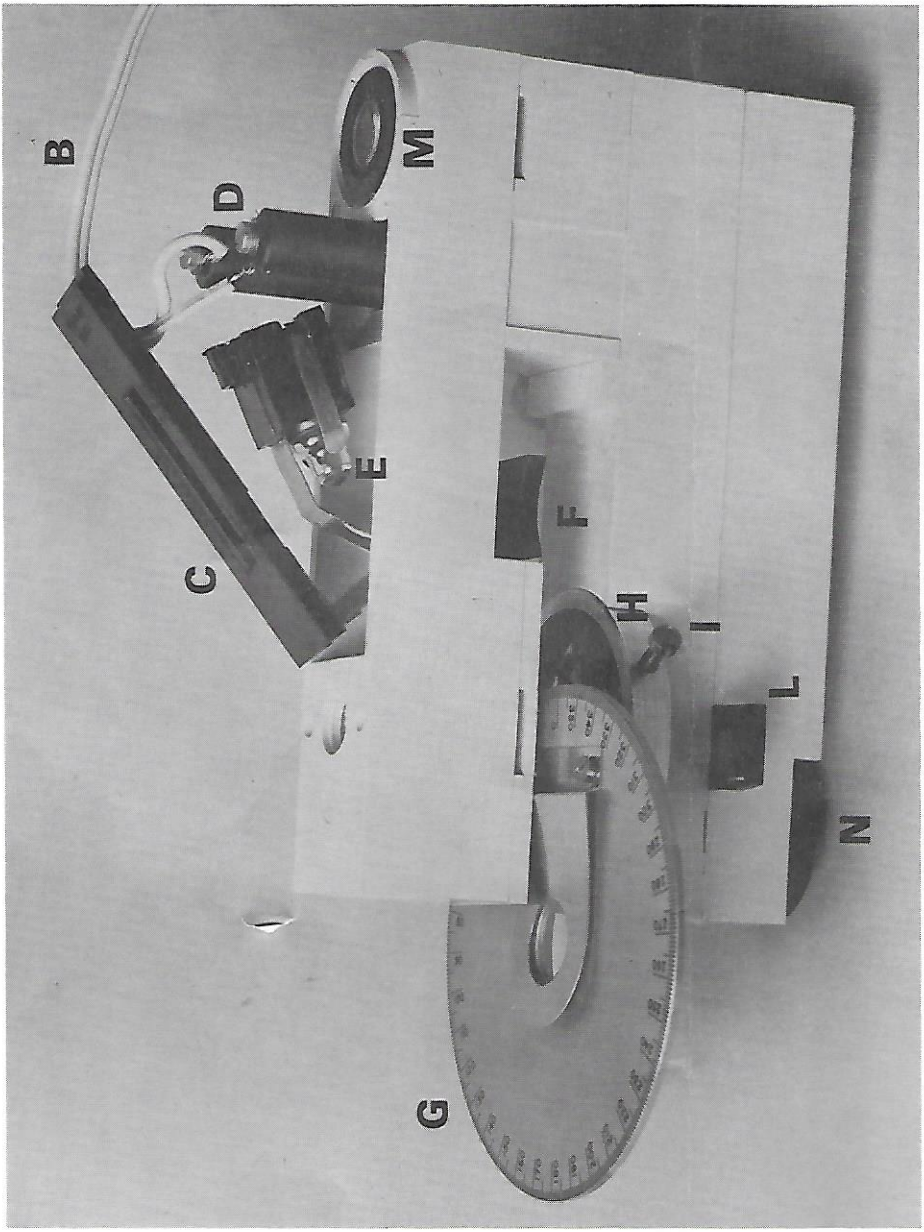

Figure 2

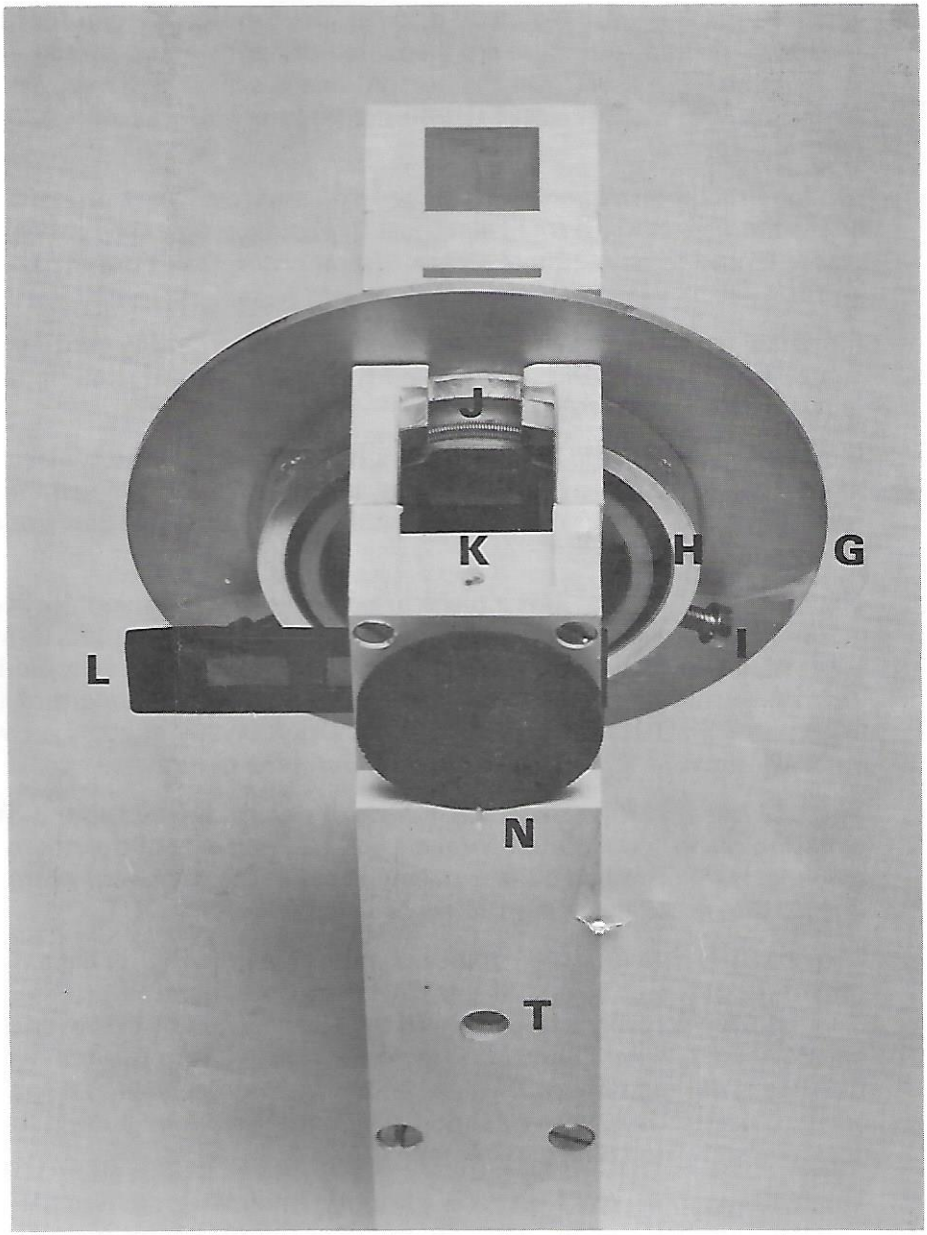

Figure 3

The rotating stage (G) is a metal disc. On the top side is a clip for holding the glass slide, and there are graduated divisions round its edge, in 1° intervals from 0-360. On the bottom side is a circular flange. This flange fits into the flat sleeve (H) on the body of the microscope. Assembly steps are:

(i) Unscrew the two screws (I) (Fig. 1) till they no longer protrude inside the sleeve. Use a small electrical screwdriver, and keep it handy as you will need to adjust these screws several times. Don't use the kitchen knife!

(ii) Draw back the small tension spring (J) at the front, by putting a pair of tweezers between points J and K in Figure 3, and slipping the flange of the stage into place.

(iii) Lightly tighten the holding screws (I; these are also the centreing screws) so that the gap between flange and sleeve is the same all the way round (Fig. 3) but make sure that the stage can be rotated smoothly, without stiffness.

The polarizer (L) (Fig. 3) is a piece of polaroid beneath the objectives, mounted on a black plastic slide of its own, and cut so that its vibration plane is perpendicular to the long axis of the microscope. It should be inserted so that it is half way in. Once adjusted, this component of the microscope SHOULD NOT BE MOVED. Don't bother about the two *outer* windows in this slide, you will be using the centre one.

The analyser (F) (Fig. 2) is a small piece of polaroid, fitted so that its vibration plane is orientated parallel with the long axis of the microscope. It is mounted on a black push-pull slide. In its forward position, it is IN the optical system, in its rearward position it is OUT.

The objectives are mounted on a push-pull slide (K) (Fig. 1) beneath the rotating stage. The end of this slide protrudes slightly from the *front* of the microscope body. There are two objectives: the low-power objective (x8), which you will be using most often, is in position when the slide is pushed right in, flush with the microscope body. The high-power objective (x20) can be brought into the system by pulling the objective slide out to its maximum.

The focusing screw (N) (Fig. 3) is a knurled knob which moves the objectives up or down to focus. Do not over-tighten as this may damage the plastic thread.

The eyepiece (M) (Fig. 2) has a magnification of x5. It is fitted with crosswires, which are aligned parallel to and perpendicular to the long axis of the microscope (Fig. 5).

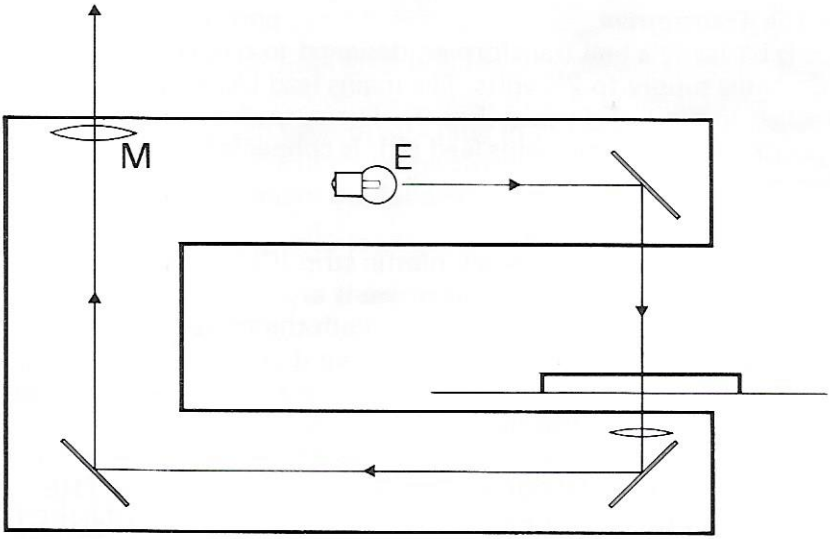

Figure 4 Optical Path. For description and letters see text.

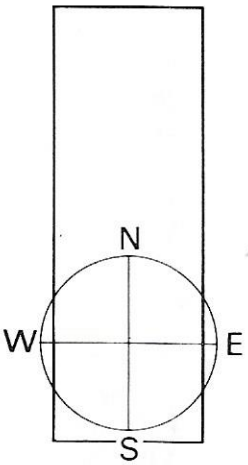

Figure 5 Crosswire alignment in eyepiece.

NOTE The direction parallel to the long axis is known as north-south, that perpendicular to it as east-west.

(b) The Transformer

This is basically a bell transformer, designed to reduce 220–250 volts A.C. mains supply to 2½ volts. The mains lead (A) is permanently attached to the transformer (Fig. 1). The output lead (B), on the opposite side from the mains lead (A), is connected to the microscope illumination system.

(c) The Illumination System

Access is by removing the black plastic strip (C) on top of the microscope—apply pressure at the end where it says 'Press to Open'. (This may be a little stiff, but *firm* pressure with the tips of both thumbs on the extreme edge of the strip should make it click open.) The output transformer lead passes through a slot in the side of the microscope body and is connected to two black cylinders (D) (Fig. 2).

IT IS EXTREMELY IMPORTANT, WHEN ASSEMBLING THE INSTRUMENT, THAT LEADS ON EACH OF THESE CONNECTORS SHOULD BE KEPT CLEAR OF ONE ANOTHER. A SMALL PIECE OF SELLOTAPE OR STICKING PLASTER SHOULD BE SUFFICIENT INSULATION.

The light bulb (E) (Fig. 2), a 2.2 volt lensed type, is a push-fit in the black block which forms part of the on-off switch, the whole of which can be lifted out if the bulb needs replacing. To remove the bulb, simply push it out of its hole with a pencil.

The *off* position of the light switch is towards the eyepiece (M) (Fig. 1), opposite the words 'Direct view' on the black plastic strip. The *on* position is opposite the words 'Electric lighting'. Ignore the intermediate position 'External lighting'.

CAUTION: DO NOT ATTEMPT ADJUSTMENTS TO THE ILLUMINATION SYSTEM WHILE THE MAINS SWITCH IS *ON*.

(d) The Tripod

A miniature camera tripod. When packed, the aluminium legs are enclosed in the black square grip. To extract the legs, unscrew the knurled knob at the *base* of the grip and pull out the legs. Replace and tighten the knob afterwards. Screw the tripod into the hole in the base of the microscope (T) (Fig. 3). The ball joint on the top of the tripod can be released by turning the oblong nut.

Testing and adjusting

1 The illumination Insert the two black cylinders (D), and the bulb (E) in its mounting, clip on the plastic strip (C)—taking care not to let the leads on D touch each other—plug in the transformer and switch on at the mains. Push the microscope switch right forward. If the light does not come on, make the following checks:

(a) That the mains supply is properly connected.

(b) Remove the plug and check that the wiring is correct and that the plug fuse (if present) has not blown.

(c) That the connection to the output lead is properly made and that the leads are not touching each other at this end.

(d) That the connections to the plastic cylinders are tight.

(e) That the switch connections have not been bent or disturbed and that the bulb (E) is fully home.

(f) If the bulb has blown, replace it.

If the light still does not come on, consult an electrician—should the transformer prove faulty contact The Marketing Division, The Open University, Walton Hall, Bletchley, Buckinghamshire.

2 The crosswire alignment Make sure the Analyser (F) is pulled back to the OUT position. Look through the eyepiece and check that the crosswires are correctly orientated with respect to the long axis of the instrument (Fig. 5). AT THE SAME TIME check that your field of view is evenly illuminated. If it is not, the polarizer (L) *below* the objectives is probably not properly in position. Adjust it, and do not move it again. Remember, you want the *central* window in the optical path.

Now push the analyser forward to the IN position. The field of view down the eyepiece, should now be nearly black, because the vibration planes of the polaroid pieces should be mutually perpendicular to each other.

3 Focusing Make sure the objective slide (K) is pushed right in, bringing the low-power objective into the system. PULL THE ANALYSER TO THE OUT POSITION. Now take your slide and put it UPSIDE DOWN (i.e. the specimen facing downwards) upon the microscope stage, beneath the stage clip. (Try not to scratch the stage with the edge of the glass as you do this.)

Now look down the eyepiece and rotate the focusing knob in either direction, until details (lines, boundaries between areas of different colour, and other features) stand out clearly. If you normally wear

spectacles, you may need to remove these. When you have obtained a satisfactory focus with the low-power objective, pull the objective slide out, to bring the high-power objective into the system, and repeat. You should only require a small adjustment of the focusing screw to obtain a sharp image. Now push the objective slide in again to use the low-power objective for the next step.

4 Centreing This is perhaps the most critical adjustment of all. With the specimen still on the stage, and focused, look down the eyepiece and slowly rotate the circular stage (G) with the thumb and middle finger of one hand.

THE CIRCLE OF ROTATION MUST BE ADJUSTED TO COINCIDE AS NEARLY AS POSSIBLE WITH THE CROSSWIRE INTER-SECTION

This adjustment is effected by the two centreing screws (I), beneath the stage, which you have already used in fitting the stage.

These screws move the *stage* in the 'NW-SE' (right-hand screw) and 'NE-SW' (left-hand screw) direction; BUT, because of the reflections undergone by the light passing through the optical system, screwing *in* the *right*-hand screw moves the *field of view* to the 'NE'. Screwing *in* the *left*-hand screw moves the *field of view* to the 'NW'.

CAUTION When rotating the stage, make sure you do not move it from its snug position up against the centreing screws—it is easy to push it forward by mistake, so that it 'floats' only against the spring. When this happens the centreing adjustment is upset.

Having read the foregoing notes *carefully* proceed with the centreing adjustment as follows:

(a) With your specimen on the stage, focus, and move the slide about so that one of the large grains is on the crosswire intersection.

(b) Rotate the stage in either direction (in Fig. 6 on p.11, we rotated the field of view to the left). Almost certainly, the centre of the circle described by the field of view upon rotation will not coincide with the crosswire intersection.

(c) Find where the centre of the rotation circle is in relation to the crosswire intersection. In our example (Fig. 6 on p.11) it is southwest of it. Clearly, we need to move the rotation centre to the northeast.

(d) Recalling the instructions given earlier, we have to screw *in* the *right* hand centreing screw, so that the whole *field of view* moves to the north-east.

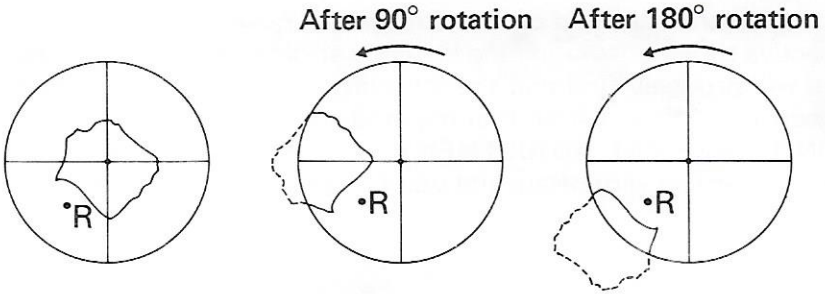

Figure 6 R = Rotation centre

(e) Having made the necessary adjustment to your own instrument, look down the eyepiece again, rotate the stage and check the new position of the rotation centre.

(f) You may now find, for example, that the centre is slightly northwest of the intersection (Fig. 7).

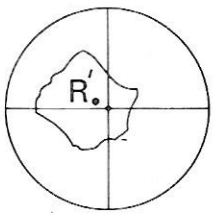

Figure 7 R' = new rotation centre.

(g) In our example (Fig. 7) we would now need to screw *out* the *left-hand* screw to move the field of view to the southeast.

Successive approximations, working systematically, will enable you to centre the field of view quite accurately.

NOTE THAT THE CENTREING DOES NOT HAVE TO BE PERFECT. In fact, if you are as close to the centre as we show in Fig. 7, it is probably near enough for most purposes.

Having centred the field of view for the low-power objective, pull the objective slide out to bring the high-power objective into the system. You will probably find that the centreing adjustment for the low-power objective is different from that required for the high-power—BUT DON'T MAKE THE ADJUSTMENT NOW. You will not need the high-power objective very often, and you can adjust the centreing when you do.

Size of field of view

IMPORTANT The combination of objective and eyepiece magnifications provides you with a field of view which is:

About 2 mm in diameter with the LOW-POWER objective.
0.5 mm in diameter with the HIGH-POWER objective.

You will need this information when estimating the dimensions of mineral grains and crystals in rock thin sections.

Measuring angles with the rotating stage

You may wish to measure the angular difference between sets of linear features observed in rock thin sections. Proceed as follows:

(a) Line up one of the linear features you wish to measure with the north-south (or east-west) crosswire.

(b) Select a *fixed* reference point in the microscope body—we suggest either the right or left-hand side of the frame where the stage crosses it—and record the value of the graduation at that point.

(c) Now rotate the stage so as to line up the other linear feature you wish to measure with the north-south (or east-west) crosswire.

(d) Take the reading on the graduated stage, using the *same* reference point.

(e) The difference between your readings is the angle between your linear features.

(Caution: if rotation of the stage takes you past the 360° mark, you must make allowances—simple subtraction will not be sufficient in such a case!)

BE VERY CAREFUL NOT TO MOVE THE POSITION OF THE SLIDE ON THE STAGE AS YOU PERFORM OPERATIONS a to d.

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