Ingram-Ward Compact Combination Thin Section Saw/Grinder Model 65C

User's Manual

v. 1.88
Ward's Natural Science Establishment, Inc.

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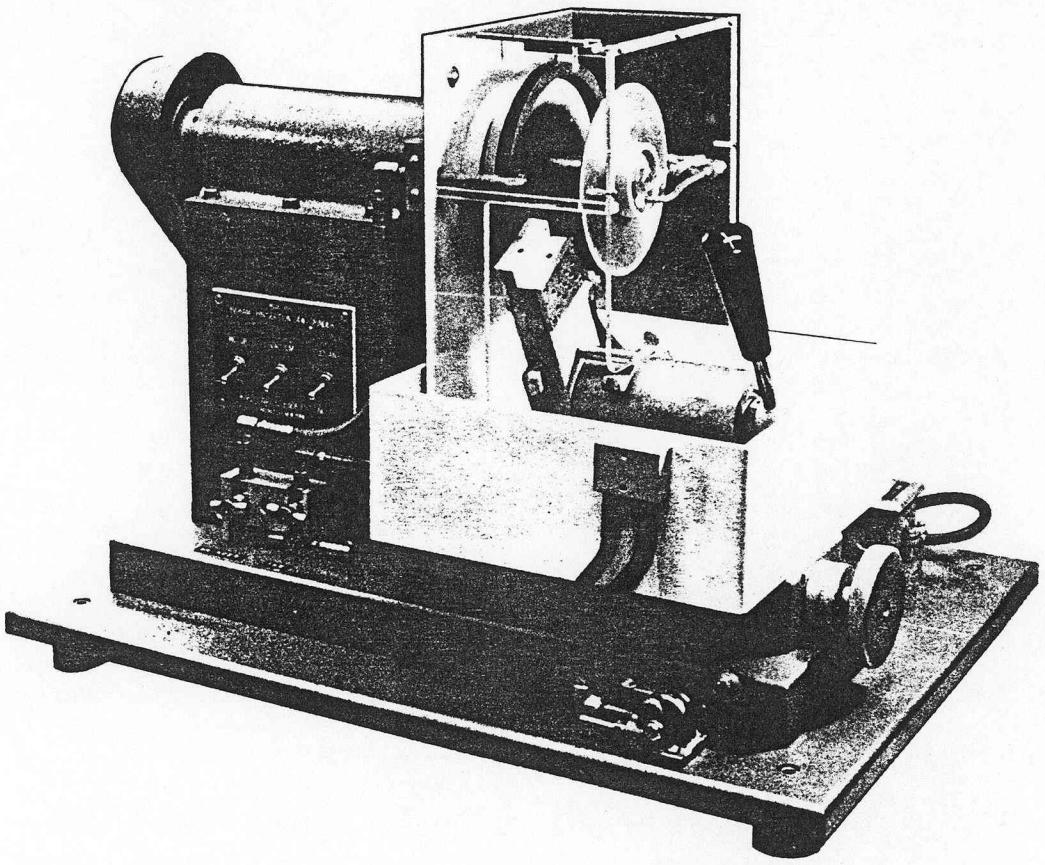
Ingram-Ward Compact Combination Thin Section Saw/Grinder Model 65C



INTRODUCTION

This manual will familiarize you with the basic set-up and maintenance of the Ingram-Ward Combination Thin Section Saw/Grinder Model 65C, and present some recommended procedures and techniques for producing quality thin sections.

UNPACKING YOUR EQUIPMENT

Your Ingram-Ward Thin Section equipment has been packed with the utmost care for damage-free shipping. If, however, damage has occurred during shipment, please notify Ward's Customer Service Department and retain all crates and packing materials for inspection.

To unpack your equipment:

(1) Remove the shipping crate top by taking out all perimeter fasteners.

(2) Remove the 2" x 4" stud above the machine by removing the fasteners on the sides of the shipping crate. Remove any items, such as dressing sticks, rubber pads, etc., which may be attached to the stud.

(3) Remove nuts and washers, found at the four corners of the machine base, which secure the unit to the bottom of the shipping crate.

(4) Check to see that the knots on the lifting ropes are tight. Using these ropes, slowly lift the machine from the shipping crate, being sure to keep the machine level. This usually requires two people. The motor end is much heavier than the opposite end, so go slowly.

(5) Place the machine on a sturdy table of proper working height (36 inches is recommended). An optional mobile lab table is also available from Ward's for more portable use. See your Ward's Geology/Earth Science Catalog for details.

(6) Remove the lifting ropes from under the machine and place a rubber pad (provided) under each corner. CAUTION: DO NOT fasten the machines to the table. Doing so may distort the base and casting and cause damage to the equipment.

With your equipment package, you should find the following items:

1 Ingram-Ward Thin Section Saw/Grinder Model 65C

4 Rubber Pads

2 Dressing sticks for saw and grinder

3 Types of tubing for vacuum pump, coolant pump, and drain

Should any parts be damaged or missing, please contact Ward's Customer Service immediately for replacement.

NOTE:

Operation of this equipment requires the use of a coolant system and vacuum pump. These may be supplied by the user, or they are available separately from Ward's. Consult your Ward's catalog for details.

SETTING UP

Coolant System

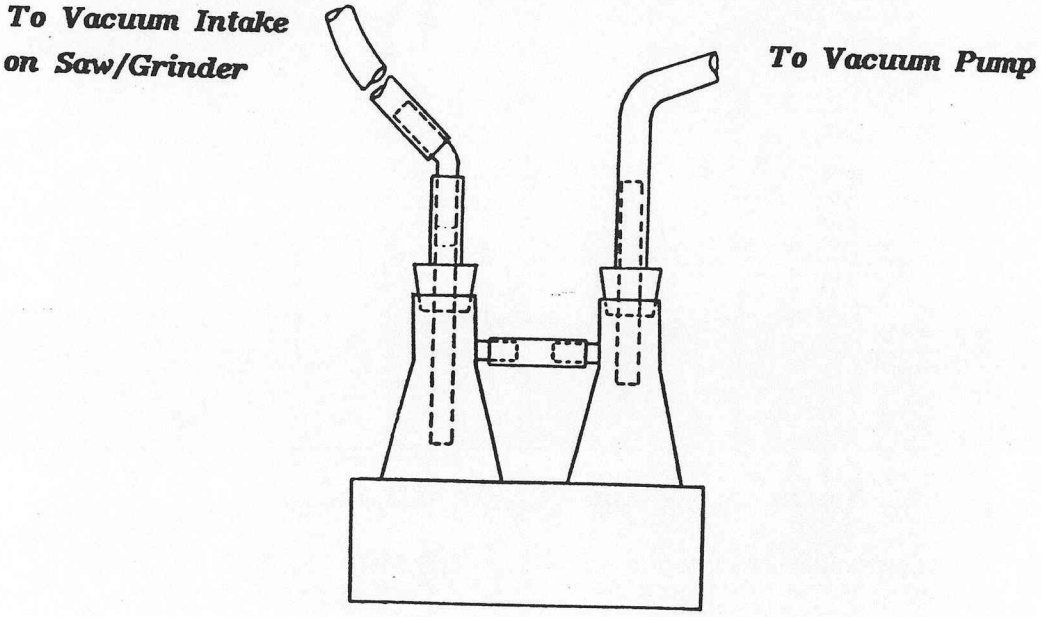
Ingram-Ward Thin Section Equipment can be used with a self-contained coolant pump system (available separately) or the equipment may be connected directly to a water line.

(1) ***Coolant Pump System** (Ward's) -- Remove the plastic cover from the coolant pump reservoir. Place the recirculating pump in the bottom of the reservoir. Connect the clear plastic tubing (1/2" diameter) directly to the pump nozzle or to the connecting tube in the rubber stopper and through the plastic top. Connect the other end to the water supply intake on the base of the thin section machine. Connect the larger plastic drain tubing (3/4" diameter) to the fitting at the back of the water catch pan (white plastic pan on machine) and route the other end to the filtered intake on the reservoir tank. Fill the coolant reservoir at least three quarters full with water or other desired coolant. (CAUTION: kerosene, toluene, or other solvent-based coolants may damage reservoir and water catch pan. Avoid their use.) Check and maintain coolant level periodically. Drain and clean sludge from the coolant pump reservoir as needed. This is important, since accumulated sludge can be recirculated by the pump, causing scratching of the microscope slide, the thin section, and the plastic coolant hood. Check to make sure all water line connections are secure. Coolant can be directed to either saw or grinder by opening or closing the check valves on the base of the unit.*

(2) ***Direct Water Line** -- If the Ingram-Ward equipment is to be connected to a direct water line, be sure to install a shut-off valve in the water line before the nozzle connection on the machine. This shut-off valve is extremely important, as the plastic tubing will not hold the static pressure of most water systems. DO NOT open the shut-off valve completely. This valve should be used to adjust the initial water flow. Since this water will not be recirculated, the coolant return tubing should be connected to the fitting at the base of the plastic catch pan and directed to an existing drain. Any drain used should have a trap that can be accessed for the removal of sediment buildup. Check the drain trap periodically for sludge accumulation and clean as needed to avoid drain stoppage.*

Vacuum System

A vacuum system is required to hold the thin section slides in place for sawing and grinding operations. Ward's Vacuum System (available separately) consists of a vacuum pump and a coolant trap. The black vacuum tubing should be connected as illustrated (see below)--from the pump to one flask of the coolant trap and from the second flask to the vacuum inlet at the base of the saw/grinder. The coolant trap should be checked frequently for sediment and coolant levels. If the coolant trap becomes filled with coolant and coolant is sucked into the vacuum pump, damage to the pump's components may result. To prevent damage, check coolant traps regularly and empty as needed. The vacuum may be shunted to either saw or grinder vacuum chuck by means of a valve (red ball) on the base of the unit.



Coolant Trap Installation

Electrical Hookup

Check the front of the Ingram-Ward Saw/Grinder to make sure that all of the toggle switches on the electrical panel are in the down (off) position. At the rear of the unit, labelled electrical outlets can be found. The outlet marked VACUUM is for the vacuum pump plug and is controlled by the vacuum toggle switch on the front panel. Similarly, the outlet marked COOLANT is for the coolant pump plug and is also controlled by a single toggle switch on the front panel. These outlets should be used when a single coolant pump and a single vacuum pump system are used.

The Ingram-Ward Compact Combination Thin Section Saw/Grinder is wired for 110 volt, 60 Hz operation (unless specified for overseas shipment) and comes with a three-prong plug. It should only be plugged into a receptacle of the same voltage. DO NOT TURN ON THIS EQUIPMENT UNTIL THE FOLLOWING CHECKLIST HAS BEEN COMPLETED.

(1) Check the vacuum and coolant tubing for kinks and make sure all connections are tight. Also check tubing for any sludge accumulation.

(2) Check to see if water jets are properly adjusted with the water flinger and that they are not touching the saw blade, grinding wheel, or spindle.

(3) Check the rocker arm assembly to make sure it has sufficient clearance from the saw blade or grinding wheel and will not hit either if moved forward accidentally. Be sure the rocker arm is also resting on the splash shield brace before starting motor.

(4) Be sure rubber pads are properly positioned under the corners of the machine.

(5) Check the belt tension on the drive system and make sure there are no obstructions in the housing.

(6) Check to see that the pins on the vacuum chuck plate do not extend beyond the thickness of your microscope slide.

(7) Empty the coolant trap in the vacuum system.

(8) Turn on the vacuum pump.

(9) Make sure the vacuum switch is in the proper position for desired operation (saw or grinder).

(10) Turn on the coolant pump.

(11) Make sure coolant is properly directed to either saw or grinder. Adjust pressure as needed.

(12) Turn on the saw/grinder motor.

GENERAL OPERATING PROCEDURES

Saw Blade and Grinding Wheel Preparation

It is absolutely necessary to dress (sharpen) the diamond saw blade and diamond cup (grinding) wheel regularly in order to keep them in proper condition for cutting and grinding. It is a simple process that requires only a few seconds but is often neglected. Please read the following instructions carefully.

Saw Blade

The cutting edge of a sintered diamond blade is made up of diamond particles in a matrix or bonding material of metal. Actual cutting is performed only along this thin rim of diamond impregnated matrix. For this surface to cut, the diamond particles must be exposed. The dressing process is one way of abrading away the metal bond with an abrasive dressing stick, furnished with the machine, thereby exposing the angular particles of diamond for better cutting. This is done quickly and easily by feeding the dressing stick into the rotating saw blade by hand and making several 1/4 inch or so cuts. Always use abundant coolant. A new diamond blade must always be dressed before attempting a cut.

For most materials, an average rate of cut should be about one square inch per minute. Softer or harder materials require less or greater time. When the rate of cutting appears to become too slow, DO NOT resort to greater pressure. This may worsen the situation. Stop cutting and re-dress the blade. Certain materials, such as very hard, compact granites, quartzites, and particularly cherts and agates, tend to burnish the metal bond over the diamond and reduce the cutting action. Forcing the blade to continue cutting under these conditions may irreversibly damage the blade. Simply dress the blade regularly when cutting seems reduced. When properly maintained, the diamond saw blade provided should last for several thousand cuts, depending upon the type of materials being sawn. If the blade ceases to cut properly even after dressing, it may be time to replace it. Inspect the rim of the blade for wear. If the diamond matrix material on the rim has been worn down to the thinner metal core of the blade, it's time for a new blade.

Diamond Cup Wheel

The flat rim of the diamond cup wheel must also be dressed to keep it "sharp" and grinding properly. The situation is essentially the same as with the saw blade, but with a few differences. The bonding material in the diamond cup wheel is a vitreous material rather than metal and is somewhat porous. This porous surface tends to become filled or loaded with particles from the rock sample being ground, and more especially from the cementing material holding the chip to the slide. A cup wheel will load up almost immediately if a relatively large area of the cement material is ground. This is most evident when epoxy-type cements are used.

The wheel may be unloaded (sharpened) in a matter of seconds by gently applying the flat surface of the dressing stick (furnished with the machine) against the cutting surface of the wheel. Slow grinding, scratching, gouging, and plucking of sections while grinding is almost always due to a loaded wheel. As with the saw blade, too frequent dressing is preferable to insufficient dressing. Continuing to grind with a loaded wheel will not only ruin the section being ground, it can cause serious damage to the wheel. With proper care, the average diamond cup wheel should last for up to ten thousand sections.

Making Thin Sections

Developing capability in the art of thin sectioning requires proper technique and procedure to ensure a quality end product. The key factors for making quality thin sections with the Ingram-Ward machines include proper chip preparation, uniform thickness of microscope slides, and even application of the mounting medium. When skill and technique in these areas have been achieved, the Ingram-Ward units will produce sections of excellent quality. These critical techniques of specimen preparation and mounting are explored later in this manual under "Keys to Better Thin Section Preparation". In this section, however, we will cover the general operating procedures for the saw and grinder once a specimen has been prepared and mounted for sectioning.

Cut-Off Saw Operation

The Ingram-Ward Cut-Off Saw is designed to remove the bulk of the prepared specimen chip from the slide, leaving a relatively thin layer of material for finish grinding. In the Model 65C, the saw and grinder are designed into a single unit with a common arbor, while in the Universal and Standard Ingram-Ward machines (Models 400U, 400, 137U, 135) the saw and grinder are stand alone units.

Before operating the saw:

(1) Make sure the face plate of the vacuum chuck is completely free of dirt or grit. To clean, use a lint-free cloth.

(2) Inspect the back surface of the specimen slide to be sawn and remove any excess mounting medium that may appear on the surface with a razor blade.

(3) Turn on the vacuum pump. On Model 65C, make sure the vacuum switch (red ball) at the front of the unit is in the proper position for sawing. Moisten the back surface of the glass microscope slide to which the chip has been cemented. Depress the vacuum release valve and carefully place this slide surface on the face plate of the vacuum chuck. Avoid sliding your sample onto the vacuum chuck, as this may cause scratching of your slide. Make sure the microscope slide fits against all four stop pins on the chuck. At this time, it is well to check the vacuum system for possible leaks. This may be accomplished as follows: After vacuum pump has run for a short while with the microscope slide in place on the chuck, test to see if it is being held firmly in place. Leave the microscope slide in place; turn off the vacuum pump. Wait a few seconds and test again by trying to remove the slide. Now activate the vacuum release valve. If air can be heard rushing into the valve, the system is free of leaks. If, however, the slide loosens quickly when the vacuum pump is turned off, or no air rush is heard upon opening the valve, a vacuum leak is present. The most common leaks occur around the rubber stoppers in the coolant trap. Make sure they are fully seated in the flasks. Dirt or grit on the vacuum chuck or excess epoxy on the back of a slide can also cause an improper seal.

(4) *After positioning the slide on the vacuum chuck, set the micrometer on the side of the machine so that the desired thickness of the chip will be left on the slide after the saw cut. A good average thickness is .020 inches. Once the desired thickness is established, the micrometer setting should be left in this position for subsequent sawing. The graduated collar may be set at "0" for this position if desired. Remember, the glass microscope slide and the mounting medium layer will vary somewhat in thickness. This will result in a thickness variation in the sample when the micrometer is left in a fixed position. Obviously, the thicker the slide, the thinner the remaining sample after sawing.*

(5) *Turn on the coolant pump and saw motor. Adjust the coolant valve so a firm spray of coolant bathes both sides of the cutting edge of the blade. It may be necessary to bend the coolant lines slightly. Direct the lines into the water flinger. In all saw models, be sure that sufficient coolant is used. Too much coolant does no harm. Too little coolant can cause excessive blade wear and possible overheating of the chip. If the blade itself overheats, some diamonds may work loose from the bonding material, thereby decreasing the life of the blade.*

(6) *Fold the hinged Plexiglas guard over against the main coolant hood.*

(7) *Hold the rocker arm loosely by the handle and slowly move the sample into the blade. Visually check to make sure your thickness setting leaves adequate clearance for the vacuum chuck before fully engaging. Hitting the blade with the metal stop pins or chuck will likely damage both the blade and the chuck. Once your slide sample is clearly engaged, maintain a steady uniform pressure until near the end of the cut. Toward the end of the cut, reduce the pressure slightly. The rocker arm should be moved fully forward until the stop bar is reached, then retract the rocker arm to its original position with the motor still running. When cutting, DO NOT force the sample into the blade. Apply only sufficient pressure to draw the sample at an even rate through the blade. Dress the blade as needed.*

(8) *Activate the vacuum release valve and remove the slide from the chuck by lifting with your thumbnail. The sawn section is now ready to be placed on the grinder for finish grinding.*

Grinder Operation

(1) Follow steps 1 and 2 as outlined in the Cut-Off Saw operation.

(2) With the sample slide in place, position the rocker arm so when it is moved back and forth, the chip on the slide will clear the surface of the diamond cup wheel. On Model 65C, it will be necessary to place the slide on the opposite side of the vacuum chuck from your sawing operation and move the rocker arm assembly into position for grinding as described above.

(3) Turn on the coolant pump and grinder motor. Adjust the coolant valve so an ample amount of coolant sprays across the full width of the cup wheel. This will help keep the surface of the cup wheel flushed clean, lubricate the surface to be ground, and prevent the sample from heating. Again, as with the saw, too much coolant is better than too little.

(4) Fold the hinged Plexiglas splash shield over against the main coolant hood.

(5) Hold the rocker arm handle loosely with the left hand. While moving the rocker arm back and forth, slowly move the micrometer slide advance forward with the right hand. Approach the cutting surface of the cup wheel very carefully, keeping the rocker arm constantly moving in short forward and backward arcs until light contact is made with the surface of the cup wheel. As soon as contact is made with the cup wheel, begin to make longer arcs, carrying the sample ON-ACROSS-OFF the full width of the cup wheel. It is important to move the entire section over the width of the cup wheel surface to insure the section will be ground uniformly. This procedure will also serve to keep the surface of the cup wheel flat.

ALWAYS keep the rocker arm moving back and forth; NEVER grind the section in one stationary position on the wheel. Advance the section by the micrometer slide ONLY when the section is in contact with the cup wheel. Never advance the micrometer slide when the section is off the surface of the wheel. If this is done, a shearing action results which may seriously damage the thin section and possibly the edge of the cup wheel.

(6) During grinding, periodically remove the thin section from the vacuum chuck and check it for thickness. For a quick check, use two sheets of polarizing film held in crossed position. Place the thin section between these crossed polarizing films and hold up to a light source for viewing. Using a birefringence chart, you can then determine the relative thickness of key minerals and whether or not the section is being ground evenly and is near completion. If a more precise check of thickness is desired, you may use a hand micrometer or polarizing microscope.

(7) As with the saw blade, the surface of the grinding wheel will have to be dressed from time to time to flush any particle buildup. (See section on Diamond Cup Wheel, page 6.)

(8) *If the chip has been carefully prepared and mounted parallel to the flat glass slide, the section may be finished to correct optical thickness on the grinder. If the thin section does not appear to be grinding evenly, it is due most likely to an error in surface preparation or mounting of the chip before grinding on the machine. (See "Keys to Better Thin Section Preparation".) It may be possible to save the thin section by finishing it on a flat glass plate with #600 silicon carbide grit. This is a fairly simple process, but care should be taken when applying selective pressure to the slide to avoid loss of any specimen surface area.*

(9) *If hand finishing is required, make a water-silicon carbide slurry on the glass plate. Place the thin section, chip side down, in the slurry and move the specimen in a "figure eight" pattern with your fingers. Be sure to use the whole surface of the glass plate to prevent creating low spots on the plate over time. For selective grinding, apply even pressure with a pointed wooden dowel to the area of the thin section that is the thickest. Move the slide in a circular or "figure eight" pattern and check frequently for overall thickness. Add water or more abrasive to the slurry as needed to maintain a fluid grinding surface. Working in this manner, many slides which may have ultimately been lost because of poor preparation technique, can usually be salvaged.*

MAINTENANCE

Generally speaking, the Ingram-Ward Thin Section machines are relatively maintenance-free. If kept clean and not abused, they will produce excellent thin sections for many years, requiring only periodic replacement of diamond saw blades and diamond cup wheels as use demands. Follow these few basic procedures to assure quality thin section production and to help maintain equipment operating efficiency and condition:

(1) After completing use of the equipment, wipe bare metal surfaces dry and periodically coat them with a light machine oil. DO NOT use penetrating oils, as these can be corrosive.

(2) Periodically remove and clean the vacuum face plate pins. These can seize in place after continuous use and become difficult to remove. A pin vise is recommended for removing and replacing these pins. Replace the pins, making sure they are seated deep enough not to damage the diamond saw blade or the cup wheel during operation of the rocker arm. The pins should not extend beyond the thickness of the microscope slides in use. They should always be seated slightly below slide level so that they do not come in contact with the saw blade or cup wheel during operation.

(3) When operating this equipment, keep coolant return hoses free of foreign material buildup. Coolant should never be allowed to accumulate in the coolant catch pan to the level of the rocker arm assembly bearings. Keep drain clear, and remove excess chip material from catch pan after use each day.

(4) If the coolant traps overflow into the vacuum pump, simply place your finger over the exhaust nozzle of the pump, creating pressure to blow the coolant from the unit. Remove the vacuum hose from the pump during this procedure. If, after a period of time, the vacuum does not seem to be drawing air properly, some internal components may have either weakened or clogged. Repair or replacement may be required.

(5) Keep micrometer slide advance free of dirt and grit by cleaning periodically with compressed air.

(6) NEVER LOOSEN BOLTS on the machine (except when changing saw blades or grinding wheels), especially on the rocker arm assembly. Alignment of this assembly with the diamond cup wheel is critical. If a suspected problem with alignment occurs, refer to the troubleshooting portion of this manual first for possible causes. If procedural steps do not correct the problem, contact Ward's Customer Service Department for technical assistance. DO NOT attempt alignment repairs without factory assistance. Most such repairs can only be done by factory-trained personnel.

(7) Check the rubber "V" belt between motor and spindle periodically for proper tension or signs of wear. Keep foreign materials out of the drive belt housing to avoid damage to belt or pulleys.

TROUBLESHOOTING

Defect	Possible Cause	Remedy
Slides breaking when approaching 30 micron thickness	Different coefficients of expansion of epoxy, glass, and chip set up stresses which can cause fractures	Review mounting temperature and materials used. Equal balance.
Saw marks across chip	Chip fed into saw too rapidly	Slow feed rate
	Drifting saw blade	Dress saw blade more frequently. Reverse saw blade periodically
	Damaged saw blade	Examine blade for rim damage. Repair or replacement may be required.
Breaking slides	Micrometer feed too fast	Slow feed rate
	Saw blade drifting into glass slide	Reverse saw blade periodically.
	Loaded or damaged saw blade	Dress blade and inspect for damage.
	Vacuum not holding	Check vacuum pump intake and clean vacuum chuck plate and back of glass slide. Check hoses for leaks.
	Feeding chip into saw too fast	Slow feed rate
Checking (fine fractures) in section	Grinding too close, producing thinner than normal sections, usually at first and last contact points between grinder and specimen	Check more frequently for correct thickness

Defect	Possible Cause	Remedy
Chip pulls off glass slide	Micrometer feed too fast	Slow feed rate
	Improper epoxy mix (ratio of hardener to resin)	Review mixing instructions and methods
	Bonding between chip and slide inadequate	Frost the slide before mounting chip to increase surface area for greater bond.
	Air entrapped in epoxy layer	Review mounting technique
Scratches on slide	Grit, dirt, or foreign matter on vacuum chuck plate	Clean chuck plate
	Loaded cup wheel	Dress the wheel
Wedging of section	Chip not ground flat prior to mounting	Check chips with toolmaker's knife edge
	Slide thickness variation greater than .0005" from edge to edge	Check slide thickness with micrometer
	Epoxy layer not of uniform thickness	Apply equal pressure to back of slide when mounting
	Loaded cup wheel	Dress the wheel
	Machine out of alignment	Contact Ward's Customer Service
	Grinding too fast	Slow feed rate
Plucking of grains from section	Grains of differing hardness within rock pull out of softer matrix	Dress wheel more often. Slow feed rate.
	Grinding thin section too fast	Slow feed rate

KEYS TO BETTER THIN SECTION PREPARATION

Introduction

Your new Ingram-Ward Thin Section equipment has been built to exacting tolerances which permit preparation of a finished thin section to a thickness of 30 microns or less without additional hand finishing in most instances. Precise, dependable equipment is obviously critical to successful thin section production. However, having the best thin section equipment does not always guarantee a quality thin section. A machine will only produce a section equal to the level of skill and technique practiced by the technician. It would be fair to say, from our experience, that 95% of the problems attributed to machine misalignment or malfunction (not grinding flat, etc.) are really the fault of improper technique. This is often the primary reason many experience inconsistent results with their thin section production. No equipment can make up for deficiencies in preparation technique. It is important for technicians to spend the necessary time at the early critical stages of preparation where their efforts will assure them a better end product.

In this section, we will review some basic procedures of thin section preparation that have proven effective in Ward's own thin section laboratory. Special emphasis will be placed on the critical areas of initial specimen grinding, microscope slide selection, and mounting.

What is a Thin Section?

In the field of Geology, a petrographic thin section is normally a fragment of rock or mineral which has been mounted on a glass microscope slide and ground to a paper thin layer (usually 0.03mm or 30 microns) for optical study. Obviously, to achieve such a thin layer requires special procedures and equipment. The majority of problems encountered during this process lie in trying to achieve a flat, thin section that is uniform in thickness and shows no evidence of major fracture or loss of specimen area. Here the technique and preparation prior to use of thin sectioning equipment is critical. All variables in microscope slide uniformity, chip or specimen flatness, and an even epoxy or other cement layer must be worked out before the final steps on the equipment. We will assume the quality of the glass slide and its index of refraction are adequate, and the mounting medium being used is a good workable product with a refractive index equal to that of the glass slide.

Specimen Preparation

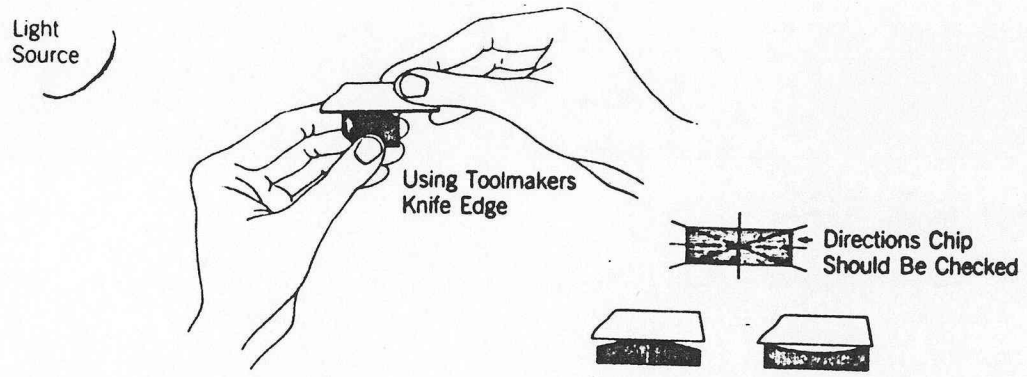
The specimen to be sectioned should be washed in a suitable medium and labelled. A chip should then be cut from the bulk sample to an appropriate size for mounting using a diamond slab or trim saw. The length and width of the chip will depend upon the size of the thin section desired. For most standard petrographic slides (27 x 46 mm), a chip size of around 25 x 35 mm is usually good. The thickness of the chip should be enough to grasp easily with your fingers, but generally not more than 1/2" to 3/4" so that it will easily clear the Plexiglas coolant hood on the Ingram-Ward Cut-Off Saw when engaged. Squareness of the chip will also facilitate more efficient sawing.

If the specimen is particularly porous or exhibits many open voids, surface coating or impregnating the chip may be desired before grinding. In this case, coarse grind the surface of the chip on a flat lap and wash the chip when finished. Allow the sample to dry on a hot plate. Mix the epoxy or other mounting medium according to directions, and thin slightly with xylene or other solvent. Using a wooden spatula or other tool, apply the epoxy mixture to the ground surface of the chip until the epoxy will no longer permeate the surface. Level the epoxy by placing a glass slide over the chip and then carefully slide it off to reduce excess and eliminate grinding through an uneven surface. Cure the epoxy-coated chips on a hot plate until the epoxy is hard. If multiple sections are to be made from the sample, you may wish to impregnate the chip by immersing it in the epoxy mixture under a vacuum for 2-3 hours. Occasionally break and restore the vacuum seal to help force the impregnating solution into the specimen. Allow the chip to dry thoroughly before further grinding.

Grinding the Chip

After the chip has been cut to size and surface coated if needed, the next concern is achieving a flat chip surface for mounting. In preparing a specimen for mounting, you can use sophisticated lapping machines with diamond, or a simple glass plate with silicon carbide. Whatever you use may be dictated by cost and desired output, but the characteristics of the finished chip or specimen should be the same. After lapping with a progression of silicon carbide grits or diamond disks (to a minimum grit size of 600), the surface of the chip to be mounted must be perfectly flat and smooth. Check for surface flatness periodically with a proven technique. A "toolmaker's" knife edge can be used for this purpose. (See Diagram A.) Rest the knife edge on the ground surface of the chip while holding it up to a light source. Looking straight across the flat plane of the chip, check for light passing between the knife edge and the ground surface from length to width for any irregularities or low points. If light does appear between this contact zone in any one of the positions, the chip is not uniformly flat and should not be mounted. Lapping should continue until no variations are noted.

Diagram A



Lapping is one of the most critical areas of thin section preparation. When not performed correctly, it will result in the loss of the thin section later on during final machine grinding. (See Diagrams B & C.) A few minutes spent developing a good lapping procedure can save many hours of doing slides over again. Once this procedure has been worked out, it will become less necessary to check for flatness on each sample as you become more skilled and accustomed to your own technique and lapping ability.

Diagram B

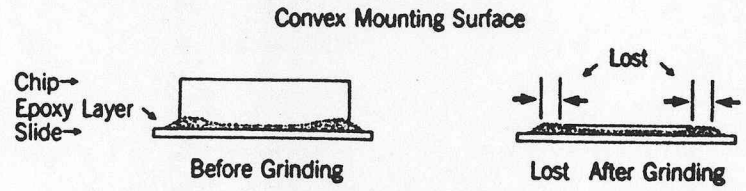
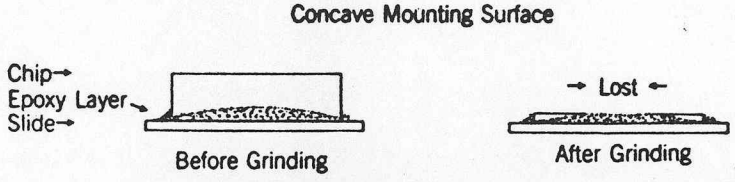
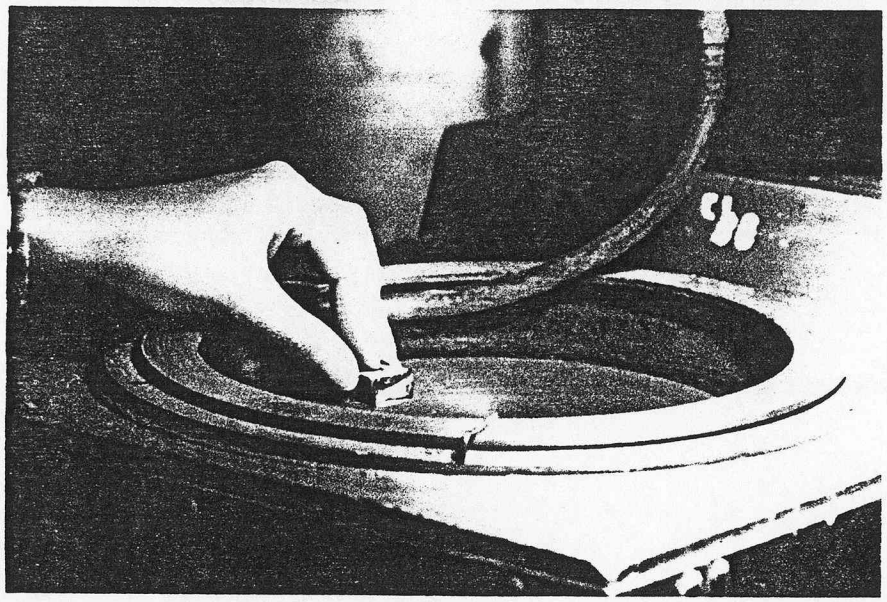


Diagram C





Surface Lapping of Chip

Microscope Slide Variations

The second area to consider in thin section preparation is the glass slide. Many slides will vary in thickness, from one end to the other, by more than .001 inches. This variation will make it almost impossible to get a flat, uniform thin section from any equipment used. Since the vacuum chuck on the Ingram-Ward machines and the cutting surface are parallel and have been ground to exacting tolerances, both slide surfaces must be perfectly parallel to achieve a flat finished section.

All slides should be checked with a micrometer before being used. This applies to both plain and frosted slides. Most frosted slides are either chemically frosted or sandblasted, and any irregularities in parallelism of top and bottom surfaces would remain after treatment. Using the micrometer, measure the thickness at both ends and the middle of the slide. Subtract the lowest reading from the highest reading. Any difference greater than .0005 inches will cause serious problems when grinding your section to a tolerance of .001 inches (the standard thickness of most petrographic thin sections). The usual result is a loss of specimen area during final machine grinding or the need to do excessive hand finishing to salvage the section.

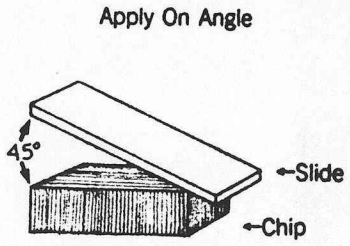
To solve this problem, you could place the blank slide on the Ingram-Ward grinder and grind it down to uniform thickness before mounting the chip, or you can simply continue checking your stock of slides with the micrometer until slides of uniform thickness are found. Generally, sections on slides with slight variations of .0005 inches or less can be salvaged fairly easily by removing the slide from the grinder before fracturing or loss of specimen area occurs. The section can then be hand finished to completion by selectively grinding on a glass plate using silicon carbide #600 grit. Taking these relatively simple steps of checking slide uniformity before mounting can save hours of wasted effort and many ruined sections.

Chip Mounting

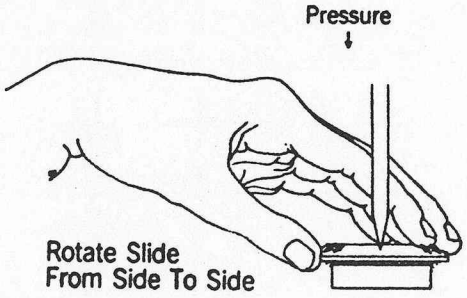
The last major area of concern is achieving an even medium (epoxy) layer between specimen and glass slide when mounting. It always seems enough of a problem mounting a chip without entrapping air bubbles in the medium. It is important to try to eliminate these bubbles, but it is only secondary to producing an even, uniform layer. The type of medium you select for this operation can save you time and effort. A number of different epoxy products, as well as Canada Balsam, are among those media in general use. Epoxies tend to form a stronger bond, are easier to use, and have a better index of refraction. Some media cure at room temperature, others require added heat, and still others cure with ultraviolet light. Your choice of medium may be dictated by desired results and the type of specimen being mounted. Working time may also be a factor. Whether hot or cold mounting the specimen, and regardless of the medium you choose, the following procedure has proven effective once the medium has been applied to the chip.

To avoid as many air bubbles as possible, position the glass slide at a 45 degree angle along the edge of the chip. (See Diagram D.) Carefully lower the glass slide until complete contact has been made between the chip surface and the slide. Work out any trapped air bubbles by applying light pressure to the back surface of the slide with the eraser end of a pencil or pointed wooden dowel. After all air is removed, press firmly in the center of the slide with the dowel (or pencil eraser) and rotate the slide in a circular motion with your other hand. (See Diagram E.) This pressure and slide movement will disperse the medium evenly and result in a uniform layer between chip and slide. (See Diagram F.) Failure to achieve this uniform layer may result in loss of specimen area during machine grinding. (See Diagram G.) Do not apply too much pressure, or the medium might be completely forced from the center, creating a dry spot. When the mount has dried thoroughly, the sample is ready for sawing and finish grinding on your thin section equipment. (See GENERAL OPERATING PROCEDURES, page 5.)

Diagrams D & E



D



E

Diagram F

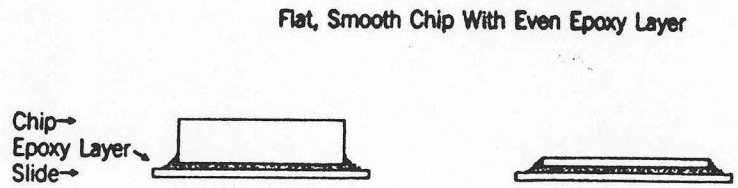
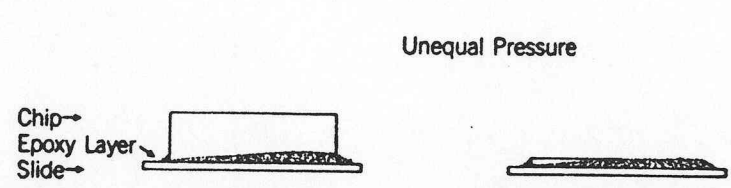


Diagram G



Final Preparation

The final step in completing the thin section is the application of the cover slip. The cover slip protects the finished ground surface of the sample and improves clarity for optical viewing. The cover slip should be applied with a medium having an index of refraction equal to glass and be free of impurities. After your section has been ground to final thickness, wash the section and allow it to dry in a dust-free environment. Apply a thin layer of covering medium on the section and slowly lower the cover slip onto the finished slide. Carefully remove any air bubbles as outlined under Chip Mounting. Don't apply too much pressure, or the thin cover slip will crack. After hardening, any excess media can be carefully removed with a razor blade. The section is now ready for study.

CUSTOMER SUPPORT

Your new Ingram-Ward Thin Section equipment has been designed, manufactured, and tested to perform efficiently and dependably for many years of service. The procedures and techniques outlined in this manual are designed to provide basic background information which will further insure the longevity and performance of your equipment. Please read all instructions carefully. In the event you experience difficulty in the operation of any Ingram-Ward equipment, Ward's professional staff is ready to help.

--If you are experiencing difficulty in setting up or operating the equipment, or require technical advice on proper procedure or technique, contact Ward's Thin Section Manager.

For Technical Assistance CALL TOLL FREE: 1-800-962-2660.

--In the event repairs or replacement parts are ever needed, all work is handled through our manufacturer in Griffin, Georgia. Contact Ward's Customer Service Department for details and shipping instructions.

For Customer Service CALL TOLL FREE: 1-800-962-2660.

SUPPORT EQUIPMENT

The following support equipment is available separately from Ward's and is designed for use with all Ingram-Ward Thin Section equipment. All Ingram-Ward saws and grinders require a coolant system, coolant trap, and vacuum pump for operation. Suitable equipment may already be available in your laboratory, or you may wish to purchase these specific Ward's products. Complete descriptions and pricing information may be found for these and other related products in your Ward's Geology/Earth Science Catalog.

Catalog Number	Description
28 E 1920	Coolant Pump System
28 E 1921	Coolant Trap
21 E 7410	Vacuum Pump
15 E 8570	Mobile Thin Section Lab Table
28 E 1901	Replacement Diamond Saw Blade - 5 inch (For Models 65C and 135)
28 E 1907	Replacement Diamond Saw Blade - 7 inch (For Model 137-U)
28 E 1915	Replacement Diamond Cup (Grinding) Wheel (For all Models 65C, 400, and 400-U)
28 E 1927	Dressing Sticks for Cut-Off Saws (1" x 1" x 6")
28 E 1928	Dressing Sticks for Grinders (1/2" x 1/2" x 6")

Accessory Materials - *Suggested items for basic thin section production needs.*

Catalog Number	Description
25 E 4600	Polarizing Film Disks - 2-inch diameter, set of 2. (For checking specimen thickness/birefringence.)
15 E 4700	Metric Micrometer (For checking slide/specimen thickness.)
13 E 0801	Petrographic Microscope Slides, Etched 27 x 46 mm, Package of 72
13 E 0800	Petrographic Microscope Slides, Plain 27 x 46 mm, Package of 72
14 E 3245	Cover Slips (glass) - 24 x 40 mm, 1 oz. package

Catalog Number	Description
15 E 4509	0151 Epoxy Mounting Medium - Kit, 2 tubes (Resin - 2.54 oz./Hardener - .81 oz.) Sufficient for mounting several hundred slides.
37 E 9550	CR-1 Cover Glass Mounting Medium - 4 oz. bottle.
	Silicon Carbide Abrasives
28 E 1480	80 Grit
28 E 1490	100 Grit
28 E 2510	120 Grit
28 E 2520	220 Grit
28 E 2530	320 Grit
28 E 2540	400 Grit
28 E 2560	600 Grit
14 E 3582	Slide Warmer Table - 0 to 100 degrees C. (For hot specimen mounting and curing.)
28 E 1233	Petrographic Specimen Polisher - 5 speeds, 115V. (For lapping chips.)
28 E 1658	Slab and Trim Saw (10") - 110V with diamond blade. (For cutting and sizing chips.)
30 E 4801	Petrographic Slide Storage Box Capacity: 100 slides, 27 x 46 mm.

WARD'S
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