Thin Section Lab Cookbook
Polished and Standard Thin Section Preparation

Introduction

Thin sections are made in order to study microscopically the mineralogy, petrology, paleontology, internal structures and fabrics of rocks and sediments. Thin slices of rocks (billets) are mounted on glass slides and usually ground to a thickness of 35 microns. At this thickness, the thin section will easily transmit light. Various optical tests can thus be performed, or fossils and structures studied, with the aid of the petrographic microscope. Additional polishing of one or both sides of the thin slice of rock enhances the optics, yielding greatly increased resolution.

This lab provides thin sections of lithified and non-lithified materials. Technicians can provide single or multiple sections. A Buehler Petro-Thin thin-sectioning system creates single sections. A Logitech LP-30 lapping machine can produce up to 100 high quality thin-sections a week. The technicians have the ability to cover slip the slides with a liquid cover slip or polish the slides with a Logitech PM2A Precision Polishing & Lapping Machine. Both the LP-30 and the PM2A have ABS1 Abrasive Auto Feed systems. All thin sections are the property of ODP, but may be borrowed for study.

Before arriving on site the technician should talk with the staff scientist and scientists who will be interested in thin-sections to get an estimate of how many may be requested. At least this many frosted slides should be made.

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Preparation

I. Cutting and Labeling of Billets and Frosting Slides

The cutting of a rock billet is the first step in the preparation of a thin section. The thin-section lab technician should check the core lab for new thin section samples at the beginning of shift. The scientist or technician should cut down the thin-section samples to proper size before being placed in a sample bag. Check to make sure the billet is not too large to fit on a slide before taking the sample away to the thin-section lab. There are billet templates in the saw area for use as size reference. If billets are fragile or broken they may need to be epoxied before trimming. It is helpful to make the upper and lower surfaces of the billet as flat as possible. The rock specimen should be held firmly with both hands. The forearms or elbows should be rested on or against the table of the saw and on either side of, but back from the blade. The rock specimen should then be gently pushed into the spinning blade with slow, even pressure. If too much pressure is applied or the water supply is inadequate, sparks will be generated. The water supplied to the blade should therefore completely bathe it for maximum lubrication and cooling.

Once the samples are in the thin section lab they need to have an identification tag epoxied to the billet. The billet must have both a relatively flat top and bottom so that it can be pressed and glued to the slide correctly. Print the sample identification information onto a small label. If the sample is oriented, make sure an orientation arrow is on the label. Using 5-minute epoxy glue the label onto the sample. If the sample is moist it may need to be dried in the oven at a low temp (<100º degrees F) for a short time before the epoxy with hold. Log the sample information into the thin section lab log book (blue book).

Frosting slides: Glass slides need to be frosted to insure a flat surface onto which a thin section billet can be glued. There are three jigs associated with the LP30 polishing machine. One jig should be set up for frosting slides. Using the micrometer, assure that the jig is within flatness specifications. Set the depth on this jig to 1000 microns. If time permits, two or more jigs can be set up to frost slides. Make as many slides as possible before getting on site. Using a micrometer sort the slides in order of thickness so that they (the frosted slides) will not be a major factor in determining the thickness of the thin section preparation.

II. Impregnating

Rocks which are altered, weathered badly, or which contain a high clay content may need to be impregnated with epoxide plastic (Epo-tek 301 2-part epoxy) to hold the specimen together while thin sectioning. This is not always necessary and will not be routinely done to hard rocks. The Epo-tek epoxy is a very thin liquid that penetrates pore spaces well. Once mixed it cures within hours, but it should be allowed to sit overnight to ensure that the epoxy is completely cured.

These samples must be dried thoroughly at low temperature (100°F) in the oven. Place the sample in an appropriately sized impregnation mold and keep it in the oven until dry. Sturdy samples can be freeze-dried to speed up the process. After the sample is dry mix up some of the thinner two-part epoxy (not 5-minute epoxy). The epoxy must be well-mixed with a wood applicator; there should be no ‘tailing’ of unmixed epoxy as the applicator is moved through the mixture. Once the epoxy is ready it can be poured into the impregnation mold. This thin epoxy will fill voids and pore spaces better than the thick 5-minute epoxy. Pour the epoxy in to the impregnation mold and allow it to soak into the sample. Place the impregnation into the vacuum bell jar assembly and apply vacuum slowly. The epoxy will often form bubbles or foam – when this happens, release the vacuum slowly until the bubbles disappear, then slowly re-apply the vacuum. The sample need not be kept under the vacuum very long – less than a minute is sufficient. Once the sample is thoroughly impregnated with epoxy, remove it from the apparatus and let harden overnight.

Following immersion in Epo-tek epoxy, the billet and impregnating medium should be placed under vacuum to withdraw all air from the billet. The vacuum should be broken and restored occasionally. This will force the

impregnating medium into the small pores of the rock. This process is usually complete after 1-2 minutes. After impregnation is complete, remove the impregnation mold and billet from the vacuum and allowed it to cure overnight.

If there are large pore spaces or cracks in a hard-rock billet, epoxy can be used to surface-impregnate the voids. Use the thin epoxy to fill the areas, then wipe it away with a glass slide. Re-lap the sample down to 600-grit once the epoxy is dry.

Once the epoxy is dry the billet should be lapped flat. Either lap the sample on the Buehler lap wheel or use the automatic Logitech LP30. If using the Buehler lab wheel, make sure the steel wheels are appropriate for the sandpaper or grit that is being used. Start with 240- or 400-grit (depending on the condition of the sample) and work down to 600-grit. The Logitech LP30 will use only the 600-grit slurry. If the sample has a high clay content the lapping must be done with either oil or kerosene, as water will cause the clay to expand, potentially destroying the sample. The slurry solution for the LP30 can be made with an oil-based solution.

The billet is made flat on one face; it must be optically flat before it is mounted on a frosted glass slide. The surface to be cemented to the glass is first ground to an optical flatness. Wetness and cleanliness of the wheel together with proper technique in handling of the billet are essential to obtaining a smooth, flat surface. The billet can either be flattened by hand or with the Logitech LP30.

The wheel must be absolutely clean before each new grinding operation begins. It is put in motion and a water drip is started on its surface. The drip is regulated so that the wheel stays slightly more than damp. If the wheel feels very slick, it is too wet. If it grabs, the wheel is too dry. The 600-grit alumina is lightly dusted over the surface of the wheel when it has been
properly dampened. A thin, even slurry of alumina and water should be made to cover the entire surface of the wheel so that even dampness is obtained. The billet is held with 3 fingers: the thumb and middle finger hold the edges and the index finger presses down on the center. It is placed in the center of the wheel and moved out toward the edge in a spiraling fashion, using moderate pressure. When finished, it should also be removed from the center of the wheel. Grinding motion is made in the opposite direction of rotation from that of the wheel. The billet should be rotated 180° every tenth revolution.
Periodically, more grit is sprinkled on and proper dampness maintained. On some minerals the paste of used grit and rock powder tends to be grabby making it difficult to hold the billet or slide and may contribute to grain plucking in some circumstances. Frequent cleaning of the lap wheel and fresh grit minimizes this problem. In the preparation of doubly polished thin sections, the ground billet surfaces are polished using 3 micron grit diamond polishing compound. This procedure is described completely in a later section on polishing.

III. Mounting

Once the billets are lapped flat they can be cleaned before being epoxied to a frosted slide. Place the billet in an ultrasonic bath for a minute. Note: If the sample is clay rich or fragile do not use the ultrasonic bath as it may damage the sample. Once the sample is finished with the bath use isopropyl alcohol to clean any oil from the lapped face. Once it is clean, place the billet into the oven to dry completely.

When the billet is dry, mix up some Epo-tek epoxy and spread a thin bead on one edge of the flattened face of the billet. Place this glued edge against a clean frosted slide (against the frosted side, not the shiny side), then press the billet against the slide, forcing all air bubbles out as the billet is pressed down. If there are any air bubbles under the billet it must be removed and pressed down again. Once the billet is properly pressed against the slide place the piece into the thin section press on the hot plate. The billet should not be able to rotate on the frosted slide – if it rotates the billet is not flat and it must be removed, cleaned of epoxy and re-lapped. Leave the billet under the press overnight. If it dries without any bubbles underneath, then it is ready to be cut off on the Petro-Thin saw.

IV. Trimming Mounted Billet

The mounted billet is next trimmed on the Petro-Thin machine to remove excess rock. Since most of the billet can be trimmed off intact, it can be retained for making additional thin sections. The slice left mounted on the thin section should be less than 150 microns thick.

The Petro-Thin machine can be utilized both as a cutoff and a trim saw. The mounted billet is held in place on the machine for sawing by means of a vacuum chuck. A small valve on the front of the saw housing regulates water flow to the saw blade. The slide is then positioned on the vacuum chuck. The valve on the vacuum panel behind the saw should be closed to secure the slide to the chuck. It is important, in positioning the mounted billet that the edge of the rock slice chosen for initial' contact with the saw blade be clean and as nearly as possible at right angles to the surface of the slide. An uneven edge may cause blade warpage or an uneven cut. As with the Felker saw, the specimen is pushed slowly, gently and steadily into the well-lubricated blade. When sawing is complete, the slide is freed by opening the "vacuum release" valve and lifting it off the chuck.

V. Grinding the Thin Section

The thickness of the rock slice is further reduced by utilizing the Cup Wheel Grinder on the Petro-Thin machine. The slide is mounted on the vacuum chuck attachment associated with the diamond grinding cup wheel. A micrometer
adjustment on the lower right-hand side of the machine controls the rate of feed
from the chuck to the grinding wheel. It is possible to set as a reference point
on the dial indicator the thickness of section desired in thousandths of an
inch or microns. The slide is placed on the grinder vacuum chuck and positioned as it was for sawing. Using the hand lever on the right-hand side, the thin section is brought even with the cup wheel. The section is brought into contact with the wheel using the micrometer dial on the lower right-hand side of the machine. It is very easy to destroy a thin section by pushing too much into the grinding wheel from the side. The thin section should be moved back and forth across the surface of the cup wheel. Water should flood the surface of the wheel. Too little water will cause scoring of the thin section. As the thin section is ground thinner, advancement of the micrometer dial is made at the rate of up to 5 microns. Dialing and back-and-forth chuck movements should be made simultaneously. The left hand operates the chuck lever and the right operates the micrometer dial. As the correct thickness is approached, the mounted rock slice will assume a greater and greater transparency. When it is transparent, micrometer advances should be reduced to 5 microns or less per turn of the dial. It is very easy to ruin the thin section at this point. When the thin section has been reduced to the proper thickness (quartz or feldspar grains in it should be red or violet in the polarized light of a petrographic microscope), the vacuum release valve above the control panel is opened, the thin section removed from the vacuum chuck, and the machine shut down. Once the proper thickness is achieved, set the “zero” on the micrometer and make all other thin sections to that thickness. A thickness of 70 to 100 microns is good.

VI. Lapping

Next, the thin section should be rinsed off thoroughly with warm water and isopropyl alcohol and lapped down to a thickness of approximately 50 microns (straw yellow of the first order, for quartz). The lapping is done on the 12" cast iron lap wheel with 600-grit alumina/water slurry, as previously described. As lapping proceeds, the thin section should be checked frequently with a micrometer and/or petrographic microscope to note the thickness of the section. Making uniformly thick thin sections is a skill which requires much practice to perfect. Each technician will develop a "feel" for the proper technique in his own way. The thin sections should be used on a jig that will have the depth set and not changed over the duration of the leg. This will ensure a standard, even thickness for all the thin sections.

The thin section should again be rinsed clean and checked for correct thickness. As the thin section approaches 50 microns, remove and clean it in preparation for polishing.

Note: the slurry solution is usually made with water, but kerosene (or some type of oil) should be used if the billets are clayey.

VII. Polishing

The final step in polishing makes use of a 320 rpm moving lap wheel mounted with a lap cloth. The lap cloth is first moistened thoroughly with polishing solution. The lap cloth is ready for use when it feels just damp. It is necessary to maintain this condition throughout polishing. Too dry a lap cloth will produce scratches and cause differential polishing of the mineral grains in the section. If it begins to grab during polishing, it has become too dry. A few drops of polishing solution should then be sprinkled on the surface of the polishing cloth. The condition of the finish should be checked frequently with a reflected light microscope. This instrument will show any surface irregularity on the thin section. (Note: if pits reappear or grow larger on continued polishing, they are probably indigenous to the rock and their removal should not be attempted.) The finished thin section should have a high polish like mirror glass and be without pits or scratches. It should be washed with alcohol, carefully dried, and stored in the thin section sample box.

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