MAKING PETROGRAPHIC THIN SECTIONS BY HAND

Petrographic thin sections of rocks are needed to identify their mineral components with a polarizing microscope. Minerals, after all, comprise the Earth as well as being sources for metals and industrial materials (requirements of modern civilizations), and so they are important! As well, the shapes and arrangements, or textures, of the mineral grains give clues to the conditions in which the rock formed, and so they tell us a lot about the geological history of the Earth.

During the 19th century, petrographers settled on 0.03 mm (30 microns) as the ideal standard thickness for a rock section. This is thin enough to make the interiors of most minerals visible (if they are not truly opaque) with a reasonable brightness of light, yet not too thin as to remove the 3rd dimension of structures within the mineral grains. To achieve this, you must glue a very flat side of a rock chip to a glass slide, then cut and grind the other side until the rock chip is an even and smooth 30 microns thick. Then glue a cover slip over the top surface, which allows most of the light to continue out of the rock straight up to the objective. Balsam cement was formerly for this, and you still can as well, but epoxy or special plastic adhesives are stronger and more common today. And, they don't gradually crystallize like balsam can.

If opaque minerals are to be studied with a reflected-light ("metallographic") microscope, the cover slip might be omitted and the rock surface polished. You don't need it mounted on a slide just for that, but a polished thin section can be used for both transmitted and reflected light studies, as well as for chemical spot analysis in an electron microprobe.

Petrographic thin sections are made commercially with automated machines that do a lot of the precise work for you. Making thin sections manually is art, not science (that comes afterward). There is no substitute for practice. I learned the basics from a grad student who made them as a part-time job. While a geology student I made several thousand thin sections (including about 700 for myself), and the ones I made for others paid almost as much as my very modest teaching stipend. I have taught several of my own students to make thin sections, and they became pretty good after just a few tries.

Equipment and Materials: Then and later as a field consultant and junior faculty member, I made thin sections of rocks on a variety of equipment, from fancy to simple. If you are patient, you can make them yourself with only a diamond blade wet saw as used for cutting tile, a piece or two of plate glass about a foot square, and fine, medium, and coarse carbide grit (about 600, 400, and 100-200 grit size). You can use store-bought epoxy (its refractive index might be a little off) or buy some from a geology or lapidary materials supplier (find them by Google, and also get some 24x46 mm (about 1 x 1/34") petrographic glass slides, as well as the grinding grit. I like Hillquist, although you might need to call them as they don't seem to respond to emails (at least, not to mine). The longer biological slides break too easily, although I have seen them used.

Slide holder. It is helpful to have something to hold the slide while you cut off the billet, and also while grinding down the face of the rock slide on the lap. Metal and plastic ones can be purchased, but I don't know where. You can cut a rectangular block of hard smooth wood a little larger than the slide. With a sharp chisel and router, cut out a flat recess on one side of the block that one slide will fit snugly and flush with the block surface. You could also make it from a block exactly the size of a slide, and fasten additional sides a little lower around the four sides of the block, to make the recess for the slide to fit. If the back is wet the slide should stick sell enough to stay in place during cutting and grinding.

Sample: Soft rocks such as marble, shale, and limestone cut easily and grind down quickly. But they tend to be very fine or mono-grained and not too interesting (except to a sedimentary petrologist, I guess). Very hard rocks such as gneiss, granite, and quartzite are interesting but difficult to cut and slow to grind. My ideal rock is the one I study the most, basalt -- not too hard, and full of interesting minerals. Just about any rock can be made into a thin section, unless it is very soluble, friable, or poorly cemented. Those must be treated in advance by impregnating them with epoxy or another hardener.

From your rock sample, break off a piece a few inches in size, using a rock hammer, ball-peen hammer, or mason (brick) hammer -- not a nail hammer! With the diamond saw, cut a "billet" or chip a little smaller than a slide, with at least one flat face. Grind that side of the billet smooth and very flat on the glass plate in a slurry of grit + water, going from coarse to fine (rinse carefully in between). When it is smooth enough it will look darker and not quite shiny. Wash it clean, and let it get very dry (a hot plate or coffee mug warmer is helpful). Mix a little epoxy in a small cup or dish, going easy on the hardener as you can force it to harden with heat. Then epoxy the flat smooth chip side to a clean glass slide. Take care to keep out bubbles -- warming the epoxy gently first makes it clearer). Only a few drops of epoxy are needed, as you want to press it flat against the glass slide. Set it on a piece of aluminum foil to cure -- if you have a warming plate (not too hot) you can cure it quickly.

After it cures, put the slide+billet into your holder block on its side, and trim the rock off carefully with the diamond saw, using the tile guide arm. Cut it as close as you can, to leave only a thin slice of rock. The closer you cut, the less you have to grind away. This is not so important with a soft rock however, which will grind down rapidly.

Then grind it down the remaining thickness on your glass plate by hand, again going from coarse to medium to fine grit. As it gets thinner, you will see some light passing through. After that, you might start checking it on a polarizing microscope (take care to not get grit and slurry on or in your instrument). A wet top surface on the slide will allow you to see enough without a cover slip. As it nears 30 microns, take it out of the holder and instead hold it down with a few fingers flat on the slide's back. Use a figure 8 pattern of movement, and cover all of the glass plate so it wears evenly (the plate is grinding down too, but it needs to stay flat). Put your fingers over the thicker parts to grind them more than the thinner. As the chip gets close to 30 microns thick (0.03 mm) the entire rock will become translucent -- check it frequently until you get it to the proper thickness.

Proper thickness: How can you tell when it is done? Under crossed polarizers, the interference colors of the common minerals will become more intense as they become thinner, thus less birefringent. Pyroxene and some other minerals might end up bright and colorful, but feldspar will end up pale gray, and quartz is just slightly yellow (called "straw yellow"). Quartz is the most useful index mineral, but feldspar is even more common. Minerals like calcite are difficult because they remain very highly birefringent at their correct thickness -- and a little more grinding suddenly removes them completely (darn, have to start over). You might need a reference book with photos of the birefringent colors, and also a graphical interference color chart, if you are not familiar with how the minerals should look. The chart illustrates "orders" of colors for minerals at various thicknesses, using lines. Very useful, so most petrographic labs have a poster sized one on the wall for ready reference. You can download a free one from the Zeiss microscopy website.

Finish by washing it well, drying it well, and cementing on a cover slip with epoxy, balsam, or some other cement (even clear fingernail polish has been used). Scratch or mark a label on the end of the slide before you forget which sample it is from. Even with a cover slip, you can determine a little about the opaque minerals by their shape, and by shining an external light onto the slide from above to see what color it is (sulfides and iron oxides are commonly different).

Practice with error is necessary to learn, so don't be discouraged by some ruined slides before you get any that are usable. Be proud when you succeed!

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