An inexhaustive guide to thin section and hand specimen description

Remember whilst making your observations why you (or we as geologists) bother to study rocks in such excruciating detail: it is to understand the history of the sample, as contained in the myriad of textural, compositional, and morphological characteristics of the minerals present. Ultimately, from the history gleaned in these detailed observations, we want to generalise to processes operating across the earth. To crystallisation and recharge in magma chambers, metamorphism in orogenic roots, and diagenesis and the paleoenvironment of sedimentary rocks. Extracting this information from thin sections is an exercise in careful detective work, a suggestion of how you should go about this snooping is given below. Each numbered block of text roughly represents a stage of the description process.

1 Hand specimen

Before looking at the thin section you should already have extracted as much information from the hand specimen as possible: there could be some larger scale features, such as bedding or crystal alignment, that can only be observed at hand specimen scale. Also, because the thin section represents such a small portion of a rock you want to make sure it is representative.

Things to mention in your hand specimen descriptions are:

- Colour: leucocratic, mesocratic, melanocratic.
- Density: in practice, does this rock feel particularly heavy given its size?
- Minerals: their relationships and distribution throughout the rock, their colour, cleavage, size, hardness and habit.
- Whether the rock is granular, or crystalline.
- Whether there is a matrix between the crystals or grains.
- Gross textural features like the presence of foliations, lineations or bedding.
- Whether the rock contains fossils. If so what is their preservation state? Fossils of what?

2 Thin section

The thin section gives you the opportunity to make a more thorough investigation of the mineral properties and relationships. Where possible try and collect quantitative information on the minerals you are observing (extinction angles etc.).

1. **Visual inspection of thin section:** Produce a brief description of the slide simply held up to the light. On this scale large textural patterns can be observed across the slide that might be missed under the microscope, like grain alignment, bulk spatial distribution of minerals, or the presence of xenolithic regions. At this scale different populations of minerals will be identifiable and modal proportions are easily estimated for the larger phases.

2. **Reconnaissance under the microscope:** Before you start drawing have a quick look around the section at lowest magnification to get an idea of what minerals and textures are present. Your drawing will be a composite of important features you have seen from all over the thin section, in crossed polars and in plane polarised light, so it is important to have seen as much as possible.

3. **Drawing the section:** You need to produce a drawing of the rock under petrographic microscope, which means creating a 'field of view' type drawing – i.e. not drawings of individual minerals floating on your page, but of all the minerals together in petrographic context as they are in the rock. The drawing should be your visual evidence base for making the interpretations of rock history and geological processes you are aiming at understanding.

   Remember that you do not have to find one specific field of view to draw, you should construct a 'synthetic' field of view that best represents the petrographic evidence you have obtained from across the section.

   Stylistic details. It is much more important that your pictures convey meaning than that they accurately reflect the infinite detail of the real thin section. To this end do not sketch, produce solid line drawn minerals, shading and varying line weight to express relief, colour, birefringence etc. Use at least half the width of a blank A4 page for making the drawing leaving plenty of room for annotations - only use this page for the drawing and annotation of the thin section. If there are details on a number of scales, such as groundmass textures, then draw a separate expanded section of the groundmass. Always provide a scale.
   For each phase. Make sure your (synthetic) field of view includes each phase in all of its relevant associations, so if it appears both as a large phenocryst and also as smaller inclusions in another phase then draw it in both environments. Record the relations between mineral phases; often minerals are systematically associated with other phases and not just floating in a groundmass, make sure the drawing reflects this. Annotate each phase with the observations that allowed you to identify it, list the observations before giving the mineral a name. This way if you pick the wrong mineral name you have at least demonstrated good observational skills. Mineral characteristics you should/could be recording and using to identify minerals are:

   - Relief (w.r.t. mounting medium and other phases)
   - Colour/pleochroic scheme
   - Cleavage (or lack of) and angle between cleavage planes
   - Twinning
   - Extinction angle, with respect to cleavage and/or long axis of crystal
   - Birefringence
   - 2Vγ
   - Length fast/slow (using sensitive tint plate)
   - Habit
   - Composition, determined from 2Vγ (olivine) or extinction angle (plagioclase)
   - Size (e.g. anorthoclase generally found in fine grained volcanic rocks)
   - Association with other mineral phases (e.g. quartz and olivine will not be found as stable phases together)

3 Summary and discussion of observations

On a separate page to your thin section and hand specimen descriptions you should summarise key observations and tabulate important quantitative data. You want to then use all your hard detective work to name the rock and describe its history.

1. **Phase summary:** Sum up the modes (relative abundance), compositions (you must determine these for plagioclase and olivine), sizes, shapes, and mutual relationships of all phases (some may appear twice if there are multiple populations of a given phase). Remember to distinguish between groundmass and phenocrystic/porphyroblastic phases. Add any other details which there wasn't room to include on the thin section drawing. Don't forget to include accessory phases.

2. **Deformation history:** For a metamorphic rock there could be multiple episodes of deformation recorded in the mineral fabric (denoted $S_1, S_2, ...S_n$). Use inclusion trails in robust prophyroblasts, such as garnet, to see as far back into the rock;s deformation and mineral growth history as possible. For low grade metamorphic rocks there may also still be relict compositional banding inherited from the protolith, such as bedding (S_0).

3. **Crystallisation/growth order:** Using textural observations and any other relevant information (2Vγ based compositions for olivine. . .) try and piece together the order in which minerals grew. This is where inter-grain relationships become important, such as whether one phase is systematically included in another. For metamorphic rocks it is going to be critical that you relate the growth order to the deformation events you have identified. Also crystal size may reflect when they started growing, as well as whether they show evidence of being unstable in their current environment. Remember to include even the groundmass crystals in this. For some rocks it will be best to summarise your conclusions graphically with a simple growth-deformation time chart.

4. **Name the rock:** Naming the rock is one step short of inferring its petrogenesis (formation history), but don't forget to name it, and list the key features (mineral modes, sizes etc.) which make it that particular rock type.

5. **Inference of rock history:** This is where you put together all the observations made to try and constrain the sequence of events the formed this rock. Work in chronological order through the rock's history, bringing in new mineral phases and textures as they are formed. Include cartoons of geological processes where relevant.