

ISU's ROCK CRUSHING & WATER TABLE INSTRUCTION MANUAL
(Modified from UA and BSU; Pearson, 9/2014)

INTRODUCTION:

This manual outlines the procedures and policies in use at Idaho State University. The main activity in our lab is separation of zircon from other high-density minerals such as titanite, garnet, monazite, pyrite, and Fe-Ti oxides. This guide describes the procedures used to generate a heavy mineral separate from a rock sample using a jaw crusher, pulverizer, and Wilfley Table.

It is important to note up-front that sample processing equipment is hazardous because of the size and power of the machines used. Everyone working in the rock crushing room must therefore be fully trained and must follow all policies and procedures.

It is also important to note that many different people use the crushing room lab. It is therefore critical that you always clean up after yourself, immediately report any problems or accidents, express any concerns that you have about lab policies or procedures, and speak up if you see any unsafe or inappropriate actions taking place. Following are a set of rules that will help ensure that all work in the lab is safe, efficient, and of the highest quality.

RULES FOR WORKING IN THE ROCK CRUSHING ROOM:

- 1) You **MUST ALWAYS USE** appropriate safety equipment (e.g., safety glasses, work gloves, closed-toe shoes).
- 2) If unsure of any procedure or situation, ask or call for help. Do not "wing it".
- 3) Do not assume that previous workers have cleaned up appropriately. Clean everything before you use it, and again after you use it. This includes all equipment, supplies, and counters.
- 4) Be gentle with the equipment – repairs and replacement parts are expensive!
- 5) Do not store samples anywhere in the crushing room, even just overnight. You never know who will be using the room while you are gone.
- 6) Do not hammer on any rocks in the crushing room -- this must be done in the rock saw/riser room.
- 7) Do not process any samples that contain unusual minerals (e.g., ore samples), because these may contain high concentrations of materials that may negatively affect chemical analyses.
- 8) Let Justin McKoon, Dave Pearson, or Paul Link know if supplies or repairs are needed.
- 9) Record all activities on the written log in the lab, including the date, your name, sample number and rock type.
- 10) If the lab is busy, you can sign up for time on the Google calendar:
(https://www.google.com/calendar/embed?src=isu.edu_pnc725vajhm33k535qt7pbc6fk@group.calendar.google.com&ctz=America/Denver&pli=1)
Please remove your name from the schedule if you cannot use your time. Don't be a no-show!
- 11) Always leave the lab cleaner than you found it!!

There are three main steps involved in processing most geochron samples. Following are guidelines that will help you process samples with a high yield of heavy minerals, no contamination of your samples and the work environment, without injury, and without damage to the equipment.

Step 1: Bico Chipmunk jaw crusher

The Jaw Crusher is a belt/flywheel driven crushing machine that utilizes steel crushing plates to reduce <5 cm size chunks of sample down to gravel size. One of the two crushing plates rotates in semi-elliptical orbit to pull sample material down to the nip point where it exits the machine at a reduced size. As crushed sample exits the machine it is captured in a new/unused garbage bag within a clean plastic bucket (generally 5 gallons or greater). The Jaw Crusher is vented in the lower rear portion of the machine and dust is vacuumed by a dust collector. Regardless of machine or method used one should always be mindful of rock dust, flying rock debris, and noise pollution.

Make sure you wear safety glasses and hearing protection when operating and cleaning the jaw crusher!!

Cleaning

This machine should be cleaned before and after each sample.

1. Wipe down the black table adjacent to the Wilfley table.
2. Remove all bolts, crushing plates and guards on the Chipmunk to facilitate cleaning and lessen the opportunity for contamination.
3. Scrub the crushing plates and bolts using soapy water and a wire brush, followed by lots of water. Scrub the machine surface and guards using soapy water and a sponge. Note: If geochemistry will also be done on the sample material, do not use soap -- soap contains a lot of Sr! When finished with the parts, place them on the clean black table.
4. Cover the engine of the Chipmunk so water does not get inside and rinse the area near the sample crushing with water (full force from a hose).
5. Clean the floor area around the jaw crusher.
6. Dry the machine and removable parts using compressed air. This dries the machine and parts, and also helps remove any sample that remains after washing and scrubbing. When dry, less dust will stick to the machine during crushing, which will make your life easier and keep things cleaner.

Operation

The Chipmunk crusher is used as follows:

7. If your samples are larger than 5 cm, they will need to be broken up first. Use a large steel plate and sledge hammer in the riser room (rock saw room). Make sure you clean this equipment and the work area really well! Do not hammer any rocks in the crushing room!
8. Make sure that the dust collection "Shop Fox" hose is securely connected to the back end of the jaw crusher. Open the gate to the Chipmunk and close the gate to the disc mill; these are located on the plastic fitting closest to the dust collector.
9. Re-attach the cheek plates and moving jaw plate to the machine.
10. Drop the clean fixed plate assembly into place, latching the top onto the steel bar.
11. Move the jaws fully apart by turning the large knob at the bottom right of the jaw crusher. The distance between the fixed and movable plate can be adjusted by turning the stubborn but adjustable cylindrical "pin."
12. Place a new garbage bag in a bucket and position it beneath the machine so that you can catch all of the sample that falls through. Tighten unused garbage bag around collection bucket as to not block the shop fox vacuum-action.
13. Start up the Chipmunk, making sure the jaws rotate smoothly (it will probably squeak like a chipmunk...).
14. Feed sample chunks into the top of the Chipmunk, using a small piece of cardboard or masonite to cover the inlet as soon as you feed the sample in—this will stop the small chips that will spall off and fly back up the feed slot!
15. Feed all of the sample through.
16. Move the jaws fully together by turning the large knob at the bottom right of the jaw crusher.
17. Feed all of the sample through again to produce a finer crush ready for the disk mill.
18. To begin cleaning the Chipmunk, remove the fixed steel plate assembly from the Chipmunk by lifting straight up— a light tap on the top handle with a hammer might be necessary to free up the assembly after prolonged use.
19. Unbolt the cheek and moving plates.
20. Brush, vacuum and blow clean with compressed air the interior of the Chipmunk. Pay close attention to the joints between the plates, cleaning each with the long steel brush. Also, make sure to look under the machine on top of the mounting steel, where there are two small ledges. Rock fragments commonly will get caught in there.
21. Clean the steel plates with the wire brush, or rotary brush on the dremel, and set aside for the next user.
22. Sweep the floor, followed by a good hose down, being careful to not wash rock fragments or large dirt particles down the drain.

Step 2: Bico Pulverizer /disc mill

The Pulverizer/disc mill is used to crush pea-size gravel fragments from the jaw crusher into fine-grained sand-size particles. There are two cylindrical plates that grind past one another, the sample being fed between the two plates. After the material is ground down, it passes between the plates into a trash bag inserted into a metal tray. The disc mill is vented in the lower rear portion of the machine and a dust collector vacuums dust. Regardless of machine or method used one should always be mindful of rock dust, flying rock debris, and noise pollution.

Make sure you wear safety glasses and hearing protection when operating and cleaning the disc mill!!

Cleaning

This machine should be cleaned before and after each sample.

1. Wipe down the black table adjacent to the Wilfley table.
2. Unscrew the securing wingnut style bolts that allow the fixed plate to swing down and out.
3. Remove all bolts for the two metal discs on the disc mill to facilitate cleaning and lessen the opportunity for contamination. Also be sure to remove the metal tray where the sample will be caught below the discs.
4. Scrub the crushing plates and bolts using soapy water, wire brush, and dremel, followed by lots of water. Note: If geochemistry will also be done on the sample material, do not use soap -- soap contains a lot of Sr! When finished with the parts, place them on the clean black table.
5. Cover the engine of the disc mill so water does not get in.
6. Clean the interior where the plates go and sample dust collects using soapy water and a sponge, followed by a wire brush and dremel, and then rinsed with clean water (full force from a hose).
7. Clean the floor area around the disc mill.
8. Clean the cylindrical sieve holder and a bucket with soap and water followed by a rinse. Position a clean trashbag in the sample tray and slide it all under the grinding plates.
9. Dry the machine and removable parts using compressed air. This dries the machine and parts, and also helps remove any sample that remains after washing and scrubbing. When dry, less dust will stick to the machine during crushing, which will make your life easier and keep things cleaner.
10. Cut a square piece of sieve screen to just fit over the bottom of the cylindrical sieve holder. Attach it to the sieve holder with the hose clamp and a screwdriver. Put a trash bag in the clean bucket and prop the sieve cylinder with attached sieve screen above the bucket.

Operation

11. Start up the dust collection bin and ensure the vacuum entrances are in proper position near the disc mill. Make sure that the proper gate is open near the entrance to the Shop Fox and that the gate to the jaw crusher is closed.
12. Fasten the clean rotating plate to the rotor with the three bolts. Loosely fasten the clean stationary plate to the side of the disk mill with the two large bolts, then raise the end of the mill up to vertical, swing the two clamps on either side of the end of the mill up and tight into place.
13. Using the plate alignment tool, align the plates carefully prior to final tightening of the two bolts.
14. Set the gap between the rotating and stationary plates so that you can just fit your thumbnail between the two plates. Rotate the plates by hand to ensure the gap is consistent.
15. Shut the upper door of the disk mill and place the trashcan with a garbage bag beneath the machine to collect the sample.
16. Start the disc mill, and slowly feed jaw-crushed sample through the entrance port. After about 16oz., stop feeding sample in, allow it all the pass between the grinding plates and then check the crushed sample in the collection pan.
17. Dump the milled sample into the sieve cylinder on top of the screen and shake it until 70-80% of the sample passes through the sieve. If less than that passes through then tighten up the gap between the disk mill plates slightly. If more than that passes through then widen the gap between the disk mill plates slightly.
18. Continue to pass the rest of the sample through the disk mill in increments, adding them to the sieve. You will need to recycle the coarse fraction from the top of the sieve back through the disk mill a couple of times. You're finished when 90% of your sample passes through the 500 micron sieve. The remaining coarse fraction can be saved. Also save the sieve paper for use with the same sample with the Wilfley table (it is expensive).
19. Spread out the sample onto a plastic bag on the clean table and pass a hand magnet over the sample (use a thin piece of plastic or paper to separate the magnet from the sample). This should remove any metal shavings present before the Wilfley table, where they could rust onto grain margins and complicate some later steps in the separation process. Keep passing the magnet over until there are no more shavings.
20. Begin cleaning the disk mill thoroughly by blowing compressed air into the entrance port with the pan in place and the doors closed. The majority of dust should go into the collection hopper. Open up the disk mill and use compressed air to blow out all the nooks and crannies of the device thoroughly, while using a steel brush and dremel on all the surfaces.
21. Clean the disk mill plates with a rotary brush (dremel), and set aside for the next user.

Step 3: Wilfley Table

The Wilfley table is the first of the two gravity separation steps and can be thought of as gold panning on a large scale. The table slopes at 25° and moves rapidly side-to-side as water flows over the table surface. Ribs on the table trap the denser mineral while allowing less dense mineral to be flushed from the table. Sample is introduced to the table surface in the sample exchange trough. Make sure this is clean before putting your sample in here!

The table effectively produces a spectrum of minerals according to density. Light minerals are flushed off the table early (on the right hand side) whereas the more dense minerals are carried to the far left side of the table where they are captured in an aluminum foil boat.

Make sure you wear safety glasses when cleaning the Wilfley table!!!

Cleaning

The Wilfley table, hopper/chute system, troughs, buckets, and floor area need to be thoroughly cleaned between samples.

1. Wipe down the black table adjacent to the Wilfley table.
2. Clean the Wilfley table with lots of soapy water and a scrubbing sponge and lots of spraying. Go easy on the ribbed table surface with the scrubbing sponge as it is fiberglass – a nylon brush works well and is less damaging to the surface. You will probably need to work from top to bottom several different times before the machine will be completely clean of sample grains.
3. Clean the sample introduction tray with soap and water.
4. Also clean the surfaces below the ribbed table (blue region where the table and engine are mounted). Be careful not to get water in the motor and electronics.
5. Clean enough small plastic buckets to fit under all the slots in the Wilfley table with soap and water and place them on the clean black table. The waste from your sample, which you will collect, will come in direct contact with these buckets!
6. Clean the floor area around the Wilfley table with the hose.
7. Inspect the Wilfley table to ensure there are no loose grains. If there are, clean it more.
8. Clean the cylindrical sieve holder and a bucket with soap and water followed by a rinse.
9. Clean a metal spoon and place it on the black table.
10. Get your sieve screen that you used for the disc mill sieving and attach it to the sieve holder with the hose clamp and a screwdriver. Put a trash bag in the clean bucket and prop the sieve cylinder with attached sieve screen above the bucket.

Operation

1. Create an aluminum foil “boat” using a sheet of aluminum doubled back on itself that attaches to the left front end of the “L” shaped piece under the table and reaches to above the midway point of the third hole in the “L” shaped piece. Fold the edges of the foil over the lip on the edge of the “L” piece and ensure that the surface of the foil slopes slightly toward the right. Fold up the right edge so there is a ~1.5-2 cm lip. You want grains to accumulate in the boat, but the water to flow off gently to the right side.
2. Hold the start switch until green light, then turn the dial to ramp up wilfley side-to-side motion. Turn it to the max.
1. Turn on the water and adjust it so a thin film is flowing continuously across most of the table. It should be roughly adjusted already so don't modify the flow in a major way! Adjust anything at this point, e.g., water flow, aluminum boat, etc.
2. Begin introducing your sample into the sample tray above the table. Start slow and wait to see if material is properly being sorted on the table.
3. Most samples (except the extremely small < 2-3 kg) are passed over the table twice. The first pass is meant to cut the sample down to 10-20% of the starting volume. This should be the amount you shoot for when adjusting the volume of water and the rate of sample delivery. As the aluminum foil boat fills with heavy minerals during the first pass, the material is spooned into a tube with disposable ~400 µm sieve screen. The fines are washed thru the sieve with a hard jet of water, and the coarse material is tossed. The sample passing through the sieve screen is captured in a clean/unused garbage bag and then passed over the Wilfley table a second time, if necessary.
4. The amount of sample retained from the second pass should be approximately 25-50 mL (about the volume of an egg) for most felsic to intermediate rocks. If the sample is mafic in composition, you may want to save a bit more, as it probably contains lots of magnetite (5.18 gm/cc), pyrite (5.02 gm/cc), and ilmenite (4.7 gm/cc). The sample should be dried with acetone in an exhaust hood in the min sep lab.