Outline –

Basic Instructions for bulk upload

- What is a Subsample?

Required format for bulk uploads:

1. Sample Upload
    - Notes on sample ownership
2. Chemical Analysis Upload
3. Image Upload

Appendices:

Appendix A. List of rock types.

Appendix B. Notes on Sample Locations

Appendix C. Metamorphic Grades

Appendix D. List of Minerals

Appendix E. List of Acceptable Units

HIGHLIGHTS ARE NOT IMPLEMENTED YET

Basic Instructions for bulk upload:

There are 3 types of bulk uploads: Sample, Chemical Analysis, and Images. These must be done from a Microsoft Excel spreadsheet (.xls file). Only the first worksheet in a .xls workbook file (first tab at bottom left) will be uploaded, so be certain that the first sheet contains the data you want uploaded for the correct type of upload.

General Advice on file organization:

There are many functional ways to do this, but I like to keep all files (images, analyses, plots, etc) associated with a particular sample in a single folder. Nested folders are OK, but I have found over the years that it gets to be very confusing where data on a sample is spread among many different folders ("…now where did I put that X-ray map???").
So a file system might be organized like this:

- Sample
  - Sample information
    - Sample photograph
    - P-T conditions
    - Plots etc.
    - Summary information
  - Subsample1
    - Maps
    - Image
    - Mnz
    - Data
    - (Each of these can be in folders or not)
  - Subsample2
    - Maps
    - Images
    - Data
    - Etc.

This type of file structure is not necessary so long as the appropriate subsample is indicated in the respective spreadsheet (see below for specifics). The important thing is to keep the chain of evidence intact – that is, you know where every image, analysis, etc. comes from.

What is a subsample?

MetPetDB differentiates among subsamples. These are parts of a sample (hand sample) that are used for different purposes. A thin section is a subsample. A polished thin section for microprobe work is another subsample. Multiple polished thin sections are multiple subsamples. A rock chip mounted in epoxy for analysis or ground to a powder for bulk analysis is another subsample. It is important to keep track of which subsample is associated with each piece of data and one way to do this is to keep subsample-specific information inside individual folders. In order to create a subsample, you must find the main sample in “my samples” and below the listed attributes is a link called “Add Subsample”. A subsample type must be specified from this list: Thin Section, Polished Thin Section, Rock Chip, or Mineral Separate.

Subsamples may also be created during chemical analysis bulk upload by providing a subsample name and the type of subsample for each new subsample. See Chemical Analysis Bulk Upload.

Required format for bulk uploads: Sample Upload

An upload worksheet contains data arranged in columns, each with an appropriate header. Below is a list of accepted headers, with notes as to which fields are required for every uploaded sample. The first row is reserved for the column headers. Each additional row should contain data for each sample to be uploaded. Only some fields are required in order to upload your data, as indicated below, but we encourage you to be thorough to maintain a database that is as versatile as possible. See the example spreadsheet for more information.

All uploaded samples will initially be private. They may then be made public once they are in My Samples. You are encouraged to check your uploaded data before making it public, as once it is public, it cannot be edited or deleted except by a system administrator, and then only to correct errors (this ensures that public data used by everyone does not change).

Sample Ownership

Every sample must have an owner, who controls access privileges for the sample. Published data is owned by the public (with the uploader referenced in the owner field) and can only be modified by the system administrator to correct errors. Also note that all sample numbers owned by an individual must be unique, as these are identifiers to MetPetDB. Ownership is assigned to the user at upload or sample entry into the database.

Some thought should be given to how you will access samples that you did not upload. Most petrologists have personal samples, and many have samples that students have collected and left behind. As samples can only belong to the user who uploaded them, it is important to clarify who should have access to these samples as part of a project. Note first that there is a separate header for "Collector" so that samples collected by a student can always be identified. Also, one can specify additional collection information as a "Comment" (e.g. Sample collected by John Doe for his PhD thesis").

The important point about a sample owner is that the owner controls access privileges. For example, if your student now works on Wall Street and you wish to continue to work on her samples, you may as long as the samples are included in a project to which you have access.

List of headers:

REQUIRED FIELDS

SAMPLE NUMBER

Each sample name must be unique to the sample owner. That is, there may be more than one sample with a specific number (e.g. 93-24) but only one sample with a particular owner can have this number.

ROCK TYPE

This is not an exercise in taxonomy. However, every rock in the database must have a name. The " Rock Type" must be from list of rock types (see Appendix A). Additionally, multiple rock names are not only permitted, but encouraged (simply add an additional rock names as "Comments" – see below). However, a single rock type is required. The list in Appendix A is largely from the British Geological Survey's recommendations.

LATITUDE

Must be between -90 and 90 (negative for south). Units are decimal degrees (DD.DDDDD). For notes on converting to decimal degrees see Appendix B. Note that five (5) decimal places corresponds to roughly 1 meter spatial resolution.

LONGITUDE

Must be between -180 and 180 (negative for west). Units are decimal degrees (DD.DDDDD). For notes on converting to decimal degrees see Appendix B.

REFERENCE – required for published data.

Data that are published require a reference to the publication. MetPetDB uses the year and the GeoRef assension number (the same as NAVDAT), which can be found from a GeoRef search. For example, "1983-018415".

OPTIONAL FIELDS

LOCATION ERROR

Units are in meters. Errors are an optional field for samples that are not well located.

IGSN

IGSN (International Geological Sample Numbers) are unique identifiers that are created by SESAR (System for Earth SAmple Registration http://www.geosamples.org/). You must register your samples to obtain an IGSN. If you have an IGSN you can enter it here. We plan to have a tool for automatic sample registration through MetPetDB in the future.

REGION

This is the region from which the sample was collected. It can be any text you choose and there can be any number of regions. Regions can be geographic (e.g. Alps, Valhalla Complex, Raging River Valley, Pine Island) or political (e.g. Vermont, Cooke County).

When specifying multiple regions, put each distinct region in a separate spreadsheet column. Each column should be headed by the word "Region". Multiple regions may also be input in the same cell if separated by a semicolon.
Also: you may want to look through the database to see if your region already exists.

COUNTRY

Where sample was collected. Pretty obvious, except where countries change names or the boundaries change. For consistency, input the country of collection at the time the sample was collected.

ALIAS (alternate sample number)

In some cases the same rock sample has been referred to by different sample numbers. These are sample aliases. There can be any number of aliases.

COLLECTOR

The name of the person who collected the sample. Preferred format: Lastname, First name middle initial.

DATE OF COLLECTION

Must be a date in MM-DD-YYYY, YYYY-MM-DD or a shortened version (i.e. YYYY, or, YYYY-MM).

PRESENT SAMPLE LOCATION

Institution, department, or lab where the sample currently resides (in case someone wishes to find the sample).

METAMORPHIC GRADE

This is the grade of metamorphism. The grade must be from the list of metamorphic grades in Appendix C. Alternate descriptions of the metamorphic grade are encouraged, and should included as "Comments".

COMMENT

There may be any number of comment columns. You can input alternate rock names or alternate descriptions of the metamorphic grade (or anything else) as comments.

For organization purposes, it is probably best to put separate types of information in separate comment columns, rather than strung together in a single comment. The key to using the comment field is to put in information that will describe the sample, and will help others find it in a search.

MINERALS PRESENT and MINERAL MODES

A list of minerals present in the sample and, if available, the modes of the minerals are very useful information. For an individual spreadsheet, the format is to

(1) Put the name of a specific mineral as the column header. Headers must be from LIST OF MINERALS (see Appendix D).
(2) If the mineral is present but the mode is unknown, put "x" in the field
(3) If the mineral is present and the mode is known, put the mode in the field (note: modes typically sum to 100%).
(4) If the mineral is not present, leave the field blank.

For example, for a suite of schists, this part of the spreadsheet might look like this:

Quartz	Plagioclase	Muscovite	Biotite	Garnet	Chlorite	Ilmenite	Zircon	Staurolite	Kyanite
x	x	x	x	x		x		x	
30	5	30	20	10		1			
x		x	x	20	x	<1	?	x	
x	x	x	x	x			x	x	x

Any text or number field is permissible and signifies a mineral is present.
Common usage included
(1) A number (= mode)
(2) < or > a number
(3) x = present
(4) ? = may be present
(5) t = present in trace amounts

Required format for bulk uploads: Chemical Analysis Upload

Chemical analyses are referenced to a sample number and a subsample, which are required (see What is a Subsample?). The sample and subsample must be uploaded/added first, before chemical analyses can be uploaded. An upload worksheet contains data arranged in columns, each with an appropriate header. The following is a list of accepted headers, with notes as to which fields are required for every uploaded analysis.

The first row is reserved for the column headers. The second row is reserved for units (chemical analysis and precision). Each additional row should contain data for each analysis to be uploaded. Only some fields are required in order to upload your data, as indicated below, but we encourage you to be thorough to maintain a database that is as versatile as possible. See example spreadsheet for more information.

Please note that chemical analyses must be in weight percent or ppm, and molar percents will be calculated by the database with a user specified method (coming soon).

All uploaded chemical analyses will initially be private. They may then be made public once they are in My Samples. You are encouraged to check your uploaded data before making it public, as once it is public, *it cannot be modified except by a system administrator, and then only to correct errors*.

List of headers:

REQUIRED FIELDS

SAMPLE NUMBER

Must correlate to existing sample in database. For information on uploading samples to the database see above.

SUBSAMPLE

Must correlate to existing subsample of the given sample number. See What is a Subsample? If a subsample has not yet been created, you may create one here, but you must provide a subsample type (see below).

MINERAL

This must be in agreement with minerals or mineral modes listed as present for the sample. If the analysis is a whole rock analysis, this field should read "whole rock".

METHOD

Method of analysis, i.e. EMP, LA-ICPMS, SIMS, etc.

SUBSAMPLE TYPE – required to create subsamples at bulk upload

In order to create a subsample during bulk upload of chemical analysis, you must specify a type for the new subsample. Subsample types accepted: Thin section, Polished thin section, Rock Chip, or Mineral separate. Subsample type only needs to be specified for the first chemical analysis for a particular subsample in a list. For example, if you have 5 garnet analyses on a new polished thin section that you want to upload, you only need to enter "polished thin section" in the subsample type column for the first (topmost) analysis.

REFERENCE – required for published data.

Data that are published require a reference to the publication. MetPetDB uses the GeoRef assension number (the same as NAVDAT), which can be found from a GeoRef search.

OPTIONAL FIELDS

ANALYTICAL FACILITY

The analytical facility where analysis was performed. This can be the name of an institution or department.

ANALYSIS DATE

Must be a date in MM-DD-YYYY, YYYY-MM-DD or any shortened version (i.e. YYYY, or, YYYY-MM).

ANALYST

The name of the person who analyzed the sample. Preferred format: Lastname, First initial.

POINT

The analysis number. It should be unique to the subsample to allow differentiation between different points for a particular subsample.

X STAGE

The stage X-coordinate recorded by a microscope or microprobe. These are in microns.

Y STAGE

The stage Y-coordinate recorded by a microscope or microprobe. These are in microns.

X REFERENCE

The X-coordinate of the analysis point on the reference image, measured in percent of the total distance from the left to right of the image.

Y REFERENCE

The X-coordinate of the analysis point on the reference image, measured in percent of the total distance from top to bottom of the image.

ELEMENTS/SPECIES – at least one required

Headers should be different elements /species (e.g. CaO, SiO2, Mg).
UNITS – must be in second row and in proper format, (e.g. wt%, ppm) - see Appendix E.
Non numerical values can be used to indicate information about an analysis as in the table below:

Values for Elements/Species can be numeric or these abbreviations:
n.d. = not determined
(blank) = not determined
n.a. = not determined (literally not analyzed)
- = not determined
b.d. = below detection
b.d.l. = below detection limit
< (a value) = less than the specified value

PRECISION

Uncertainty of measurement (relative or absolute). Each precision column must refer to the preceding column of Elements/Species concentrations, with the same units. If a data set contains different types of precision, it must be recalculated or split up and uploaded separately.
UNITS – must be in second row and either abs or rel for absolute vs. relative, see Appendix E.

TOTAL

The total weight percent of measured elements/species for this point. This indicates the completeness of the analysis to a user.

COMMENT

There may be any number of comment columns. You can input any type of description of the analytical strategy. Additional comments may also be input in the same cell if separated by a semicolon.

For organization purposes, it is probably best to put separate types of information in separate comment columns, rather than strung together in a single comment. The key to using the comment field is to put in information that will describe the analysis, and will help others find it in a search.

Required format for bulk uploads: Image Upload

Image upload is performed .zip image folder upload which includes a metadata spreadsheet on the main directory of the .zip folder. Images are referenced to a sample number and a subsample, which are required (see What is a Subsample?). The sample and subsample must be upoloaded/added first, before images can be uploaded.

Preparing .zip folder of images:

Images for database subsamples should be compiled to a single compressed folder to be uploaded in .zip format. The compressed folder must not contain subdirectories, and all image files must have unique file names that are also unique to their respective subsample's list of image files. Filenames should be catalogued in the accompanying image upload spreadsheet. Acceptable formats are: .jpg , .gif , .tif , and .png. The current size limit is 50 megabytes per image.

Note that the Image Upload Spreadsheet (image_upload.xls file) must be on the main directory of the image .zip folder!

The Image Upload Spreadsheet:

The image upload spreadsheet must be titled "image_upload.xls". Be sure the image data are on the first worksheet of the upload spreadsheet. An upload spreadsheet contains data arranged in columns, each with an appropriate header. The following is a list of accepted headers, with notes as to which fields are required for every uploaded image. The first row is reserved for the column headers. Each additional row should contain data for each image to be uploaded. Only some fields are required in order to upload your images, as indicated below, but we encourage you to be thorough to maintain a database that is as versatile as possible. See example spreadsheet for more information.

All uploaded samples will initially be private. They may then be made public once they are in My Samples. You are encouraged to check your uploaded data before making it public, as once it is public, it *cannot be edited or deleted, except by the system administrator.*

List of headers:

REQUIRED FIELDS

SAMPLE NUMBER

Must correlate to existing sample in database. For information on uploading samples to the database see above.

FILE (or PATH)

The complete filename of the image as it appears in the zipped folder, including a .xxx extension indicating the file format (e.g. samp1_polish_scan.jpg). Path notation may be used for subdirectories, using colons between each subdirectory (e.g.: zipfolder:08-1xraymaps:08-1Femap.jpg)

IMAGE TYPE

Must be from list of acceptable image types. Below is a table of acceptable image types and comments for each one. Note that abbreviations should be used for image types.

Image Type	**Abbreviation**	**Comments**
Field Notes	FIELDNOTES	Scanned/digital field notes
Drawing	DRAWING	Hand sketch or drawing
Map	MAP	Map (geologic or otherwise) with sample locations
Cross Section	XC	Geologic cross section with sample locations
Field Photo	FIELDPHOTO	Field photo of outcrop or sample location
Photograph	PHOTO	General sample imagery
Thin Section Scan	TSS	Special image of entire thin section
Photomicrograph-Transmitted Plane Polarized	TPPL	
Photomicrograph-Transmitted Crossed Polars	TXPL	
Photomicrograph-Reflected Plane Polarized	RPPL	
Photomicrograph-Reflected Crossed Polars	RXPL	
Secondary Electron Image	SE	
Back-Scattered Electron Image	BSE	
Cathodoluminescence Image	CL	
X-ray Map	XRM	Element name is required for X-ray maps

ELEMENT -required x-ray maps

The element or species that was measured to create an x-ray map.

OPTIONAL FIELDS

SUBSAMPLE

Must correlate to existing subsample of the given sample number. See What is a Subsample? If a subsample has not yet been created, you may create one with an appropriate name during bulk upload but you must supply an appropriate subsample type (see below).

SUBSAMPLE TYPE – required to create subsamples at bulk upload

In order to create a subsample during bulk upload of chemical analysis, you must specify a type for the new subsample.

Subsample types accepted: Thin section, Polished thin section, Rock Chip, or Mineral separate.

Subsample type only needs to be specified for the first image for a particular subsample in a list. For example, if you have 5 images from a new polished thin section that you want to upload, you only need to enter “polished thin section” in the subsample type column for the first (topmost) image.

SCALE

Full width of image measured along the actual sample in millimeters. For example, a horizontal scan of a full standard thin section should have a scale of ~46 mm.

COLLECTOR

The person who collected the image, as this may not be the sample owner. Preferred format: Lastname, First initial.

DWELL TIME

Value in milliseconds for x-ray maps.

CURRENT

Value in nanoAmps for x-ray maps.

VOLTAGE

Value in kilovolts for x-ray maps.

COMMENT

There may be any number of comment columns. You can input any type of description of the analytical strategy. Additional comments may also be input in the same cell if separated by a semicolon.

For organization purposes, it is probably best to put separate types of information in separate comment columns, rather than strung together in a single comment. The key to using the comment field is to put in information that will describe the image, and will help others find it in a search.

Appendix A. List of Rock Types:

Slate
Phyllite
Schist
Gneiss
Migmatite
Anatectite

Marble
Calc-silicate

Greenschist
Amphibolite
Blueschist
Eclogite

Granofels
Hornfels
Skarn

Quartzite
Jadeitite
Glaucophanite
Serpentinite
Garnetite
Pyroxenite
Cordierite-Anthophyllite

Metapelite
Metaigneous
Metaarkose
Metagreywacke
Metabasite
Metacarbonate
Metagranite

Cataclasite
Mylonite

Appendix B. Notes on Sample Location

Latitude and Longitude

Values should be entered in DD.DDDDD format. Five units after the decimal point provides a spatial accuracy of approximately 1 m (at the equator). Conversion from DD M.MMM or DD MM SS to DD.DDDDD is simple and can be done in a spreadsheet by recognizing that there are 60 S in one M and 60 M in on D.

Note that there is an optional error for latitude and longitude. If the sample is poorly located (worse than 1 meter) then an error should be specified.

With modern GPS, sample location is routine and most field geologists now locate samples with latitude and longitude routinely. For older data the latitude and longitude must be determined in some fashion. Here are several possible ways, depending on what information is currently available.

Location in UTM coordinates

If UTM coordinates are available for a sample, the conversion to DD.DDDDD can be done on a spreadsheet, but it is not trivial. The reader is referred Steven Dutch's excellent web site at
http://www.uwgb.edu/dutchs/UsefulData/UTMFormulas.HTM
Fortunately, Steven has supplied a spreadsheet for these conversions.

Locations on topomaps

If samples are located only on paper copies of topographic maps then there are a couple of options, depending on what type of software you currently have or how much money you wish to spend.

1. You can try to read the latitude and longitude directly off of the topo map. This is time-consuming and not very accurate. It is typically more accurate and faster to read the UTM coordinates and do the conversion to DD.DDD (see above). Alternatively, one of the approaches below should work still better.
2. Use the web site http://www.topozone.com/ . Topozone.com has all US topographic maps. If you can find your sample location on the appropriate map, you can read off the latitude and longitude on the screen (be sure you have the correct format DD.DDDDD and the correct map datum (NAD83/WGS84) specified). You can copy and paste individual lat-long values. This service used to be free, but now requires a subscription to http://www.trails.com/.
3. If you have good GPS software on your computer with stored topographic maps you should be able to find your sample location on the topographic map and store it as a waypoint. Waypoint files are usually ASCII (text) and can be copied into a spreadsheet. I have used MacGPS Pro (for Macintosh only) with good success.

You can find your sample location on Google Earth and read off the latitude and longitude. I don't know what the accuracy of this approach might be, but it is relatively straightforward if you can find your sample location. This method requires retyping each lat-long values.

Appendix C. List of Metamorphic Grades

Zeolite
Prehnite-pumpellyite
Greenschist
Amphibolite
Epidote amphibolite
Granulite
Blueschist
Eclogite
Hornfels
Chlorite zone
Biotite zone
Garnet zone
Staurolite zone
Staurolite-kyanite zone
Kyanite zone
Sillimanite zone
Andalusite zone
Sillimanite-K feldspar zone
Garnet-cordierite zone
Migmatite zone
Ultra high pressure
Ultra high temperature

Appendix D:

List of minerals (alphabetical):

Acmite
Actinolite
Aegirine
Aenigmatite
Albite
Alkali Feldspar
alkali-feldspar
Allanite
Almandine
Amphibole
Analcite
Anatase
Andalusite
Andesine
Anhydrite
Ankerite
Annite
Anorthite
Anthophyllite
Apatite
Apophyllite
Arfvedsonite
Astrophyllite
Augite
Axinite
Baryte
Beryl
Biotite
Boehmite
Brookite
Brucite
Bustamite
Ca Pyroxene
Calcite
Carbon
Carbonates
Cassiterite
Celestine
Celsian
Chain Silicates
Chalcopyrite
Chlorite
Chloritoid
Chromite
Clay
Clinoamphibole
Clinoenstatite
Clinopyroxene
Clinozoisite
Clintonite
Coesite
Cordierite
Corumdum
Cristobalite
Cummingtonite
Diaspore
Diopside
Dolomite
Ekermannite
Enstatite
Epidote
Epidote Group
Feldspar
Ferrosilite
Galena
Garnet
Gedrite
Ghanite
Gibbsite
Glauconite
Glaucophane
Goethite
Graphite
Grossular
Gunerite
Gypsum
Hedenbergite
Hematite
Hercynite
Hornblende
Huite
Hydoxides
Illite
Ilmenite
Jadeite
K feldspar
Kaersutite
Kalsilite
Kaolinite
Katophorite
K-feldspar
Kyanite
Labradorite
Larnite
Lawsonite
Lepidocrocite
Lepidolite
Leucite
Limonite
Magnesite
Magnetite
Margarite
Melilite
Merwinite
Mica
Microcline
Monazite
Montmorillonite
Mullite
Muscovite
Na Pyroxene
Native Elements
Nepheline
Oligoclase
Olivine
Omphacite
Opaques
Ortho- and Ring Silicates
Orthoclase
Orthopyroxene
Oxides
Paragonite
Pectolite
Periclase
Perovskite
Phengite
Phlogopite
Phosphates
Piemontite
Plagioclase
Prehnite
Pryoxmangite
Pumpellyite
Pyrite
Pyrope

Pyrophyllite
Pyroxene
Pyrrhotite
Quartz
Rankinite
Rhodocrosite
Rhodonite
Richterite
Riebeckite
Rutile
Sanadine
Sapphirine
Scapolite
Sericite
Serpentine
Sheet Silicates
Siderite
Silica
Sillimanite
Smectite
Sodalite
Spessartine
Sphalerite
Sphene
Spinel
Spinel Group
Spodumene
Spurrite
Staurolite
Stilpnomelane
Sulphates
Sulphides
Talc
Tectosilicates
Tilleyite
Titanite
Topaz
Tourmaline
Tremolite
Tridymite
Vermiculite
Vesuvanite
Wollastonite
Wonesite
Xenotime
Zeolite
Zircon
Zoisite

List of Minerals (categorized):

- Tectosilicates:
  - Nepheline
  - Scapolite
  - Silica:
    - Coesite
    - Quartz
    - Tridymite
    - Cristobalite
  - Analcite
  - Sodalite
  - Kalsilite
  - Leucite
  - Zeolite
  - Feldspar:
    - Celsian
    - Alkali Feldspar:
      - Orthoclase
      - Sanadine
    - Plagioclase:
      - Anorthite
      - Oligoclase
      - Labradorite
      - Albite
      - Andesine
- Sheet Silicates:
  - Talc
  - Apophyllite
  - Prehnite
  - Mica:
    - Wonesite
    - Margarite
    - Glauconite
    - Lepidolite
    - Muscovite:
      - Phengite
      - Sericite
    - Clintonite
    - Biotite:
      - Phlogopite
      - Annite
    - Paragonite
    - Astrophyllite
    - Chlorite
  - Clay:
    - Vermiculite
    - Smectite
    - Kaolinite
    - Montmorillonite
    - Illite
  - Stilpnomelane
  - Pyrophyllite
  - Serpentine
- Chain Silicates:
  - Pyroxene:
    - Clinopyroxene:
      - Ca Pyroxene:
        - Diopside
        - Hedenbergite
        - Augite
        - Clinoenstatite
        - Omphacite
      - Na Pyroxene:
        - Jadeite
        - Acmite
      - Aegirine
      - Spodumene
    - Orthopyroxene:
      - Enstatite
      - Ferrosilite
  - Amphibole:
    - Orthoamphibole:
      - Gedrite
      - Anthophyllite
    - Clinoamphibole:
      - Hornblende
      - Kaersutite
      - Glaucophane
      - Cummingtonite
      - Tremolite
      - Richterite
      - Katophorite
      - Ekermannite
      - Riebeckite
      - Arfvedsonite
      - Gunerite
      - Actinolite
    - Aenigmatite
    - Rhodonite
    - Bustamite

- Pryoxmangite
- Sapphirine
- Wollastonite
- Pectolite

Ortho- and Ring Silicates:

- Rankinite
- Andalusite
- Lawsonite
- Chloritoid
- Huite
- Garnet:
  - Almandine
  - Grossular
  - Pyrope
  - Spessartine
- Epidote Group:
  - Epidote
  - Clinozoisite
  - Piemontite
  - Allanite
  - Zoisite
- Vesuvanite
- Axinite
- Melilite
- Sillimanite
- Spurrite
- Sphene
- Tilleyite
- Tourmaline
- Zircon
- Mullite
- Merwinite
- Topaz
- Kyanite
- Beryl
- Cordierite
- Larnite
- Pumpellyite
- Staurolite
- Olivine

Oxides:

- Anatase
- Ilmenite
- Spinel Group:
  - Chromite
  - Spinel
  - Hercynite
  - Ghanite
  - Magnetite
- Cassiterite
- Corumdum
- Periclase
- Brookite
- Perovskite
- Hematite
- Rutile

Hydoxides:

- Diaspore
- Gibbsite
- Lepidocrocite
- Goethite
- Brucite
- Boehmite
- Limonite

Sulphides:

- Pyrrhotite
- Chalcopyrite
- Pyrite
- Sphalerite
- Galena

Sulphates:

- Gypsum
- Anhydrite
- Baryte
- Celestine

Carbonates:

- Siderite
- Dolomite
- Magnesite
- Ankerite
- Calcite
- Rhodocrosite

Phosphates:

- Apatite
- Xenotime
- Monazite

Native Elements:

- Carbon:
  - Graphite
  - Diamond

Appendix E. Acceptable Units

For Elements/Species:
wt% - weight percent
ppm – parts per million

For Precision:
wt%-abs - weight percent absolute
ppm-abs - parts per million absolute
%-rel - percent relative