**Spectral Ratio Imaging with Hyperion Satellite Data for Geological Mapping**

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## Introduction

Since the advent of LANDSAT I in 1972, many different multispectral satellites have been orbited by the U.S. and other countries. These satellites have varied from 4 spectral bands in LANDSAT I to 14 spectral bands in the ASTER sensor aboard the TERRA space platform. Hyperion is a relatively new hyperspectral sensor with over 220 spectral bands. The huge increase in the number of spectral bands offers a substantial challenge to computers and analysts alike when it comes to the task of mapping features on the basis of chemical composition, especially if little or no ground truth is available beforehand from the area being mapped. One approach is the theoretical approach of the modeler, where all extraneous information (atmospheric attenuation, sensor electronic gain and offset, etc.) is subtracted off and divided out, and laboratory (or field) spectra of materials are used as training sets to map features in the scene of similar composition. This approach is very difficult to keep accurate because of variations in the atmosphere, solar illumination, and sensor electronic gain and offset that are not always perfectly recorded or accounted for. For instance, to apply laboratory or field spectra of materials as data sets from the theoretical approach, the header information of the files must reflect the correct, up-to-date sensor electronic gain and offset and the analyst must pick the exact atmospheric model that is appropriate for the day of data collection in order for classification procedures to accurately match pixels in the scene with the laboratory or field spectrum of a desired target on the basis of the hyperspectral data. The modeling process is so complex that it is difficult to tell when it is operating well or determine how to fix it when it is incorrect. Recently RSI has announced that the latest version of their ENVI software package is not performing atmospheric corrections correctly with the FLAASH atmospheric model. It took a long time to determine that it was wrong, and may take an equally long time (or longer) to fix.

A second approach is an empirical approach, whereby the corrections for atmospheric absorption and scattering, solar illumination variations with topographic slope, and sensor electronic gain and offset are made from the image data itself, then selected spectral parameters of each pixel are compared to the reflectance spectrum of laboratory and field spectra of user-selected objects to search the image for objects that have a similar chemical composition. Spectral ratio imaging is such an empirical approach, and it is simple enough to understand that the user can determine rather quickly whether it is working properly and fix it if not. For the "extraterrestrial case" or the "military emergency case", where there are no desired objects to be mapped that have known locations in the scene being imaged at the time the data were collected, spectral ratio imaging is particularly useful. The objective of this study was to determine how useful and practical spectral ratio imaging would be for geologic mapping with a Hyperion data set of a test area near Vernal, Utah. Very little of the actual area being imaged was visited on the ground prior to the experiment, and the existing geological maps of the area contained no spectral information or enough detailed chemical information to be useful as a priori ground truth. The ground truth in this experiment was a set of laboratory measurements of rock samples collected partly in the imaged area and partly from regions off the imaged area a few months before the image data were collected. The image data from Hyperion was collected on an overpass on a Thursday morning, was transferred by satellite communications to a dish on-site near Vernal, Utah by the next morning, and by the end of Friday afternoon, geological maps had been made for each of the target rock types for the area of interest by both the theoretical (Beck et al, 2005) and spectral ratio imaging methods. This is an account of the spectral ratio imaging results.

## Background on Spectral Ratio Imaging

The following equations and methods are described in less simplified form by Vincent (1997). Let DN(i) be the digital number from the raw data coming from a hyperspectral sensor operating in the 0.4-2.5 micrometer wavelength range for the ith spectral band. Its equation can be written as follows, assuming clear day viewing conditions over a low-to-moderately varying elevation terrain and satellite viewing by a sensor that observes a field of view of only a few degrees in the imaged data:

$$DN(i) = a(i)s\rho(i) + b(i) \qquad \text{Equation (1.)}$$

Where DN(i)= digital number of ith spectral band for a given pixel in the imaged scene
a(i)= multiplicative constant (from sensor gain and atmosphere) of ith spectra band that is constant for the entire data set.
s= shadow/slope factor that can vary from pixel-to-pixel, but is same for all spectral bands.
$\rho(i)$= spectral reflectance of a given pixel on the Earth's surface for ith band.
b(i)= additive factor (the Dark Object, or D.O.) from atmospheric haze and electronic offset of the sensor, constant for the entire data set.

In this equation, all of the information about the chemical composition of a given pixel on the Earth's surface is found in the $\rho(i)$ term for all of the spectral bands taken together (i=1 to n, with n= number of spectral bands of the sensor). To separate the effects of changes in chemical composition from pixel-to-pixel from other effects (such as brightness differences across the image produced by shadow and slope variations), two terms must first be removed: b(i) and s.

Removal of the b(i) term is called Dark Object Subtraction (D.O.S.), and it is done by the following empirical method. First, a histogram of the entire data set for the ith spectral band is constructed (use of every pixel in the data set is best), which is a plot of the number of pixels (the population) with a given DN(i) value versus that DN(i) value. The highest DN(i) value that still has a zero population is b(i), because it represents the situation where either s or $\rho(i)$ are zero, for most large scenes. In unusual circumstances, such as a large, flat desert scene completely covered by sand (with no vegetation, no spatially resolvable gully shadows, and no standing water), b(i) is estimated by this D.O.S. method to be too high. Otherwise, this is usually a good approximation. Second, this step must be repeated for all n bands of the sensor, such that we determine the b(i) for each spectral band. Third, the b(i) must be subtracted from the DN(i) of each pixel in the data set for each spectral band separately. The resulting dark-object-corrected digital number, DN(i)' is given by the equation:

$$DN(i)' = DN(i) - b(i) = a(i)s\rho(i) \qquad \text{Equation (2.)}$$

where DN(i)'= the dark-object-corrected digital number for the ith spectral band.

The next procedure is designed to get rid of the s factor, which is the only other term besides $\rho(i)$ in Equation (1) that ordinarily changes from pixel-to-pixel. To get rid of this term, we will ratio the ith spectral band by the jth spectral band (after D.O.S.) for each pixel in the data set, which divides out the s term because it is the same for all bands (slopes and shadows are relatively independent of wavelength).

$$R(i,j)= DN(i)'/DN(j)'= [a(i)s\rho(i)]/[a(j)s\rho(j)= [a(i)/a(j)][\rho(i)/\rho(j)] \quad \text{Equation (3.)}$$

Where R(i,j)= the dark-object-corrected spectral ratio of spectral band i to spectral band j, for each pixel in the data set.

In this equation, the a(i)/a(j) term is the same for the entire data set (under the assumptions made in the first paragraph), and only $\rho(i)/\rho(j)$ varies from pixel-to-pixel, as chemical composition changes on the ground. This R(i,j) can be imaged and will have almost no effects of shadowing or terrain slope information in it; the dark-object-corrected spectral ratio changes across the scene will be caused by compositional differences only. To make this a complete tool for compositional information, however, only those spectral ratios that are likely to include one spectral band inside a common absorption band for a target of interest and one outside that absorption band will be employed for the analysis. The reason for this course of action is that the spectral locations (wavelengths) at which $\rho(i)$ changes rapidly with wavelength (an absorption band) are controlled by the chemical composition of the material being observed. For reasons discussed in the text book, but not here, this also tends to suppress changes in particle size on the ground of the surface materials, which tend to make the reflectance brighter or darker, but do not tend to change the spectral locations of the absorption bands. For a given rock or mineral, selecting those R(i,j) for which values are very high or very low, relative to other rocks and minerals, is like looking for the distinguishing characteristics in the face of an average-sized human, such as a brown mole, for identification, rather than giving the height and weight for that person. When images of R(i,j), called spectral ratio images, are produced, they can be contrast-stretched to make the lowest and the highest values of R(i,j) in the data set be set to 0 and 255, respectively, with digital numbers in between that are proportional to R(i,j). This essentially suppresses variations in a(i)/a(j) from overpass to overpass. For a given rock or mineral type for which you have a reflectance spectrum ($\rho$ versus wavelength), if an R(i,j) that is relatively (compared to other minerals and rocks) high is made into a spectral ratio image that is displayed in red, and two other spectral ratios, say R(q,r) and R(s,t), that are relatively low are displayed as blue and green, then the mineral or rock "target" will appear as red. Because only 3 spectral ratios are used at one time for such a ratio color composite, there may be a few other minerals or rocks that appear red, also, but this is a very useful tool for field work because the most distinctive 3 spectral ratios for that rock or mineral were chosen.

Appendix C of Vincent (1997) has LANDSAT TM "ratio codes" for many minerals. With only 6 spectral bands of 30-meter-resolution LANDSAT TM data, there are 15 spectral ratios that can be made produced that are unique, disregarding reciprocals as redundant spectral ratios. For each of those 15 spectral ratios, the spectral ratio value for a given mineral is assigned a number between 0 (for the lowest 10% of the minerals in the library) and 9 (for the highest 10%, or decile, of the minerals in the library). Each mineral in the library, therefore, is assigned a 15-digit ratio code, with each digit showing the decile that the mineral occupies for the spectral ratio represented by that digit. For instance, if a mineral had a LANDSAT TM ratio code of 430989545054331, the R(3,2) ratio code (represented by the third digit) would be 0, which means that in an R(3,2) spectral ratio image, that mineral would appear among the darkest 10% of all the materials present in the spectral library. The mineral would have a ratio code of 9 for the R(4,3) spectral ratio (represented by the $6^{th}$ digit), making it among the brightest 10% of materials present in the spectral library. It would have an R(5,4) ratio code of 0 ($10^{th}$ digit), putting it in the darkest decile of that spectral ratio. Therefore, in a ratio color composite that displayed R(4,3) as red, R(3,2) as green, and R(5,4) as blue, the mineral in question would appear red because its ratio codes would be 9,0,0 for those three spectral ratios. Only those materials in the spectral library that had those same (or very

similar, such as 8,1,1) ratio codes for these three spectral ratios would appear reddish in that spectral ratio image color composite image. There would not be many false alarms, and selecting a second spectral ratio color composite might be found to separate some or all of these false alarms from the mineral of interest.

If Hyperion had 220 useable spectral bands, however, there would be 24,090 non-redundant spectral ratios that could be produced from those spectral bands, which are far too many to deal with for finding the best combination of three for a spectral ratio color composite. More spectral ratios (and more spectral bands) are usually better for more unique discrimination of materials on the basis of chemical composition, but at some point, the numbers become too difficult to use in a practical manner. Therefore, it is desirable to find a subset of spectral ratios that contain most of the chemical composition discrimination that the total set contains. On the basis of an M.S. thesis by Jengo (2001) and some additions that were made for this project, 34 spectral ratios from Hyperion spectral bands were selected that span the differences of the most common natural minerals. For this important subset of 34 spectral ratios of Hyperion bands, a list of ratio codes, which are deciles of each selected R(i,j) from highest as 9 to darkest as 0, is shown in Appendix A of this document for a spectral library of 475 minerals and vegetation. Appendix B contains a table that shows the limits of each decile for each spectral ratio listed in Appendix A.

## Preparation for the Field Test

Twelve rocks were collected in and nearby the Vernal, Utah test area that was imaged by Hyperion. For each of these rocks collected, a reflectance spectrum was measured with an ASD field-portable spectrometer in the 0.3-2.5 micrometer wavelength region. The average reflectance was calculated for each of 60 spectral bands (out of over 220 Hyperion bands) required to produce the selected 34 Hyperion spectral ratios listed in Appendix A. The ratio codes were calculated from the table in Appendix B for each of these 12 rock samples, and the results are shown in Table 1 below.

Table 1. Spectral ratio codes for 34 selected Hyperion spectral ratios of twelve rocks collected in and nearby the Vernal, Utah, test area. The numbers in parenthesis refer to the spectral bands of the Hyperion sensor.

| Names of Rocks/Spectral Ratios | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CM (KJ) gray mudstone (swelling clays) | 6 | 6 | 6 | 6 | 2 | 6 | 4 | 7 | 6 | 3 | 7 | 7 | 7 | 0 | 9 | 2 | 7 | 1 | 0 | 8 | 1 | 8 | 8 | 9 | 0 | 0 | 1 | 3 | 5 | 6 | 4 | 2 | 2 | 1 |
| Stump (J) light green sand/siltstone | 8 | 8 | 7 | 7 | 2 | 6 | 1 | 7 | 4 | 6 | 6 | 2 | 6 | 3 | 6 | 3 | 4 | 6 | 2 | 3 | 6 | 6 | 6 | 3 | 6 | 8 | 2 | 1 | 2 | 7 | 7 | 7 | 7 | 6 |
| Entrada (J) sandstone | 8 | 8 | 8 | 8 | 2 | 7 | 1 | 7 | 3 | 6 | 7 | 2 | 7 | 2 | 7 | 3 | 5 | 8 | 1 | 3 | 4 | 5 | 5 | 6 | 3 | 3 | 2 | 1 | 2 | 7 | 7 | 6 | 7 | 5 |
| MF (K) white sandstone | 8 | 9 | 9 | 9 | 0 | 9 | 0 | 9 | 4 | 1 | 8 | 8 | 7 | 9 | 0 | 8 | 1 | 9 | 8 | 7 | 7 | 5 | 4 | 5 | 4 | 4 | 4 | 0 | 1 | 1 | 2 | 1 | 1 | 2 |
| CM (KJ) coarse gray sandstone | 7 | 7 | 7 | 7 | 1 | 7 | 0 | 7 | 2 | 6 | 7 | 3 | 7 | 3 | 6 | 3 | 4 | 7 | 4 | 6 | 7 | 6 | 7 | 4 | 7 | 8 | 1 | 1 | 1 | 7 | 7 | 6 | 6 | 5 |
| Dakota (K) white sandstone | 6 | 8 | 8 | 7 | 2 | 6 | 1 | 6 | 5 | 5 | 5 | 5 | 5 | 8 | 3 | 8 | 8 | 1 | 8 | 9 | 6 | 6 | 5 | 5 | 4 | 3 | 6 | 2 | 2 | 5 | 5 | 4 | 4 | 3 |
| MF (K) uppermost sandstone | 8 | 8 | 9 | 8 | 0 | 8 | 0 | 8 | 2 | 6 | 7 | 5 | 6 | 7 | 2 | 6 | 6 | 5 | 8 | 8 | 6 | 5 | 5 | 4 | 5 | 6 | 4 | 1 | 0 | 6 | 6 | 5 | 5 | 4 |
| CM (KJ) pebbly conglomeritic sandstone | 8 | 8 | 8 | 7 | 1 | 7 | 1 | 7 | 4 | 5 | 5 | 4 | 5 | 4 | 7 | 6 | 8 | 1 | 6 | 8 | 4 | 6 | 6 | 7 | 2 | 3 | 3 | 1 | 2 | 5 | 5 | 3 | 3 | 3 |
| Carmel (J) red silt/sandstone | 8 | 9 | 8 | 9 | 2 | 8 | 1 | 7 | 6 | 5 | 5 | 4 | 5 | 2 | 7 | 2 | 5 | 5 | 1 | 2 | 3 | 6 | 6 | 6 | 2 | 4 | 2 | 1 | 3 | 5 | 5 | 5 | 5 | 4 |
| MF (K) Mancos lower siltstone | 9 | 8 | 8 | 8 | 1 | 8 | 0 | 7 | 2 | 6 | 7 | 6 | 6 | 2 | 8 | 6 | 8 | 1 | 4 | 8 | 4 | 5 | 5 | 7 | 2 | 3 | 2 | 0 | 1 | 7 | 6 | 6 | 5 | 4 |
| Mowry (K) light gray siliceous shale | 6 | 5 | 4 | 5 | 8 | 2 | 6 | 2 | 6 | 2 | 1 | 7 | 1 | 6 | 6 | 5 | 6 | 4 | 2 | 5 | 4 | 4 | 4 | 6 | 4 | 3 | 5 | 4 | 7 | 1 | 2 | 2 | 3 | 3 |
| Carmel (J) light greren silt/sandstone | 8 | 7 | 7 | 7 | 2 | 5 | 0 | 7 | 3 | 7 | 7 | 2 | 7 | 2 | 7 | 3 | 5 | 6 | 1 | 1 | 3 | 6 | 7 | 6 | 3 | 7 | 1 | 1 | 1 | 7 | 7 | 7 | 7 | 5 |

The approximate center wavelengths of the Hyperion spectral bands employed in the 34 spectral ratios above are given below in Table 2.

Table 2. Center wavelengths of the 60 spectral bands employed in the 34 spectral ratios of Table 1. Widths of all bands are assumed to be 10 nm.

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hyperion Band No. | 5 | 6 | 9 | 15 | 17 | 20 | 22 | 25 | 26 | 35 | 36 | 41 | 43 | 45 | 55 | 61 | 62 |
| Center Wavelength(nm) | 397 | 407 | 438 | 499 | 519 | 550 | 570 | 600 | 611 | 702 | 712 | 763 | 783 | 804 | 906 | 967 | 977 |
| Hyperion Band No. | 68 | 76 | 83 | 84 | 86 | 89 | 96 | 105 | 113 | 121 | 135 | 136 | 137 | 141 | 145 | 148 | 151 |
| Center Wavelength(nm) | 1038 | 902 | 973 | 983 | 1003 | 1034 | 1104 | 1195 | 1276 | 1356 | 1498 | 1508 | 1518 | 1558 | 1599 | 1629 | 1659 |
| Hyperion Band No. | 152 | 155 | 160 | 169 | 185 | 188 | 190 | 196 | 198 | 199 | 202 | 203 | 205 | 207 | 208 | 211 | 213 |
| Center Wavelength(nm) | 1669 | 1699 | 1750 | 1841 | 2002 | 2032 | 2052 | 2113 | 2133 | 2143 | 2174 | 2184 | 2204 | 2224 | 2234 | 2264 | 2285 |
| Hyperion Band No. | 215 | 216 | 218 | 219 | 221 | 222 | 223 | 224 | 225 | | | | | | | | |
| Center Wavelength(nm) | 2305 | 2315 | 2335 | 2345 | 2365 | 2375 | 2385 | 2396 | 2406 | | | | | | | | |

## Results of the Spectral Ratio Experiment

The successful overpass of Hyperion and collection of data in field from that overpass is described in Beck et al (2005) and will not be repeated here. The remainder of this section shows the resulting spectral ratio images from the spectral ratio imaging experiment.

The 12 figures on the following three pages show the results of displaying a spectral ratio with a high ratio code in red and two spectral ratios with very low ratio codes as blue and green for the rocks that are listed in Table 1. The order for the figures is the same order in which the rocks are listed in Table 1. In each image, the rock of interest should be red, if it is present in the imaged scene.

Figures 2(B.) and 3(A.) and 5(B.) appear to have little, if any of the "training set" rocks: MF (J) white sandstone, excluding vegetation along river; CM (KJ) coarse gray sandstone; and MF (K) Mancos lower siltstone, respectively, present anywhere in the imaged scene. That is, there is no true red in the scene in those images, except for vegetation along the river in Figure 2(B). However, the project ended before it was possible to re-visit specific areas in the field to check these results. The USGS geological map of the area is inadequate to be used as ground truth by itself because it lumps several rock types into formations and more intra-formational information is needed that only ground visits can yield for determining the map accuracies. Generally speaking, the other images showed red occurring approximately where the USGS geological map placed the respective formation in which the rock (described by ancilliary data accompanying the rock spectra that yielded Table 1) occurred. Figures 3(B), 4(B), 5(A), and 6(A) in particular appeared to correlate well with formations as portrayed by the USGS geological map.

Figure 1. A. (Left) CM (KJ) gray mudstone with swelling clays [R(188/185), R(185/198), R(207/202) displayed as rgb] and B. (Right) Stump (J) light green sand/siltstone [R(224/218), R(43/83), R(9/105) displayed as rgb]

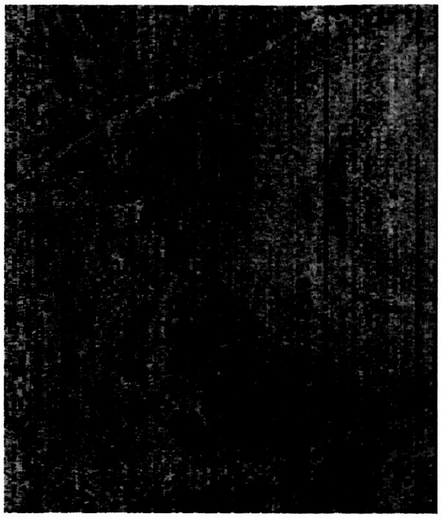


Figure 2. A. (Left) Entrada (J) sandstone [R(205/216), R(207/202), R(43/83) displayed as rgb] and B. (Right) MF (K) white sandstone [R(205/216), R(188/185), R(36/55) displayed as rgb].

Figure 3. A. (Left) CM (KJ) coarse gray sandstone [R(224/218), R(43/83), R(218/216) displayed as rgb] and B. (Right) Dakota (K) white sandstone [R(207/205), R(205/216), R(43/83) displayed as rgb].

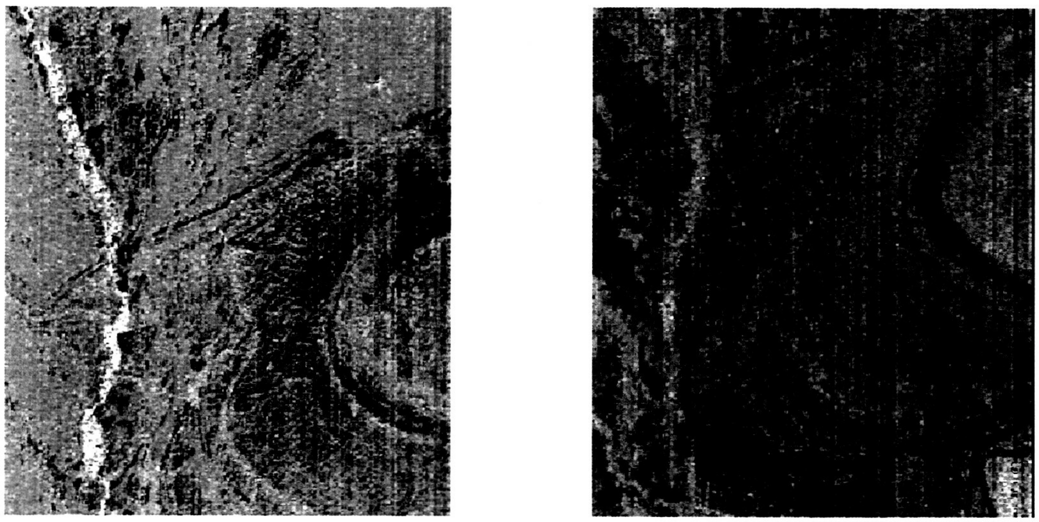


Figure 4. A. (Left) MF (K) uppermost sandstone [R(26/20), R(41/105), R(36/55) displayed as rgb] and B. (Right) CM (KJ) pebbly conglomeritic sandstone [R(196/202), R(205/216), R(36/55) displayed as rgb]

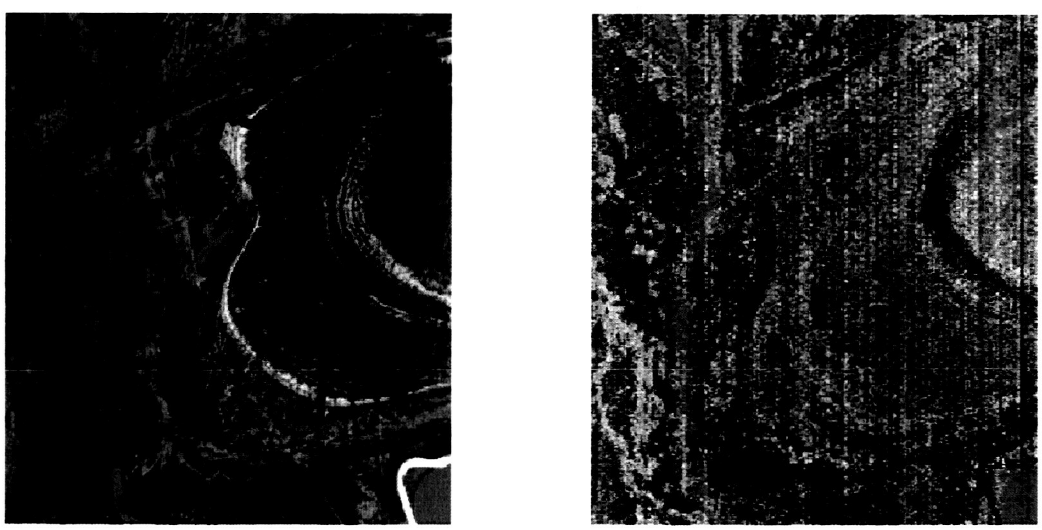
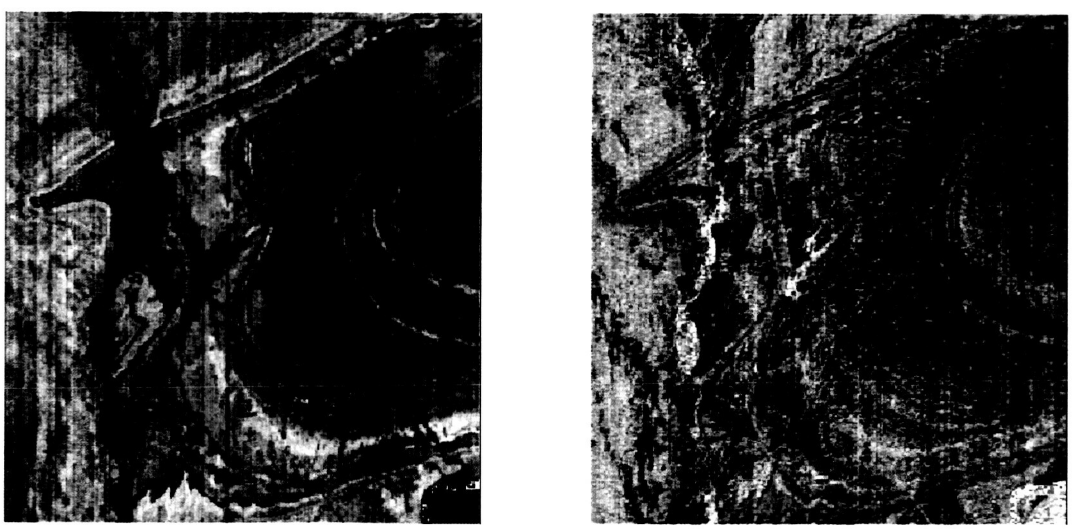


Figure 5. A. (Left) Carmel (J) red silt/sandstone [R(25/17), R(43/83), R(9/105) displayed as rgb] and B. (Right) MF (K) Mancos lower siltstone [R(188/185), R(43/83), R(41/105) displayed as rgb].

Figure 6. A. (Left) Mowry Shale (K) light gray siliceous shale [R(36/55), R(148/105), R(152/136) displayed as rgb] and B. (Right) Carmel (J) light green silt/sandstone [R(205/207), R(43/83), R(41/105) displayed as rgb].



## Conclusions

Because funding and time ran out before field tests of the accuracy of the color ratio images could be performed, it is strongly recommended that this work be followed up with more funding. This year's work cost only $15,000, and it could not be stretched further. The above results are interesting and encouraging, but they need to be compared in detail with the actual ground locations of the areas displayed as red in the images. The geological map produced by Beck et al (2005) also needs to be checked in detail on the ground, to see which of these two methods (one with theoretical and this one with empirical atmospheric corrections) is better.

There are many ramifications of this study for NASA extraterrestrial EVA activities on other planets, as well as for Homeland Security. Ratio gating logic, which is the automation of this spectral ratio imaging, is the next step in automatically classifying features in a scene from spectra of samples of materials expected to occur in that scene. It would also be very helpful in robotic vehicles that are intended to accompany space-suited or HAZMAT-suited humans into somewhat dangerous areas, with the robot going into the most dangerous areas and providing information that characterizes the chemical composition of the surfaces in those very dangerous areas. We use NASA Glenn's GRID computer to good effect on this experiment, also, to preprocess dark-object-subtracted spectral ratios at NASA Glenn before the data came to the field.

The other aspect of this experiment is that this subset of spectral ratios appears to be able to discriminate all the rocks in Table 1 from one another. This would cut the number of spectral bands down that could be employed for geological exploration. However, some of the Hyperion bands that were selected for these 34 "sweet" spectral ratios were very noisy during this overpass. If we had fewer bands 60 instead of over 220) with better signal-to-noise, results could be improved.

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## Appendix A

**Ratio Codes of 34 Select Spectral Ratios of the Hyperion Satellite Sensor for 475 USGS Spectral Reflectance Library of Minerals and Vegetation**

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a-alunit.spc Ammonioalunite | 8 | 6 | 6 | 7 | 8 | 7 | 6 | 2 | 4 | 2 | 7 | 8 | 7 | 9 | 0 | 9 | 0 | 1 | 9 | 9 | 1 | 2 | 3 | 7 | 8 | 1 | 8 | 2 | 5 | 2 | 3 | 1 | 3 | 3 |
| a-chlori.spc Ammonium_Chlc | 0 | 2 | 3 | 0 | 7 | 1 | 8 | 2 | 9 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 9 | 0 | 9 | 7 | 0 | 0 | 0 | 0 | 4 | 9 | 0 | 9 | 9 | 0 | 0 | 0 | 0 | 0 |
| acmite.spc Acmite NMNH13 | 2 | 0 | 0 | 0 | 6 | 0 | 4 | 2 | 4 | 6 | 8 | 0 | 8 | 1 | 6 | 0 | 0 | 0 | 8 | 5 | 0 | 0 | 0 | 1 | 8 | 8 | 8 | 9 | 7 | 7 | 8 | 9 | 9 | 9 |
| actinol1.spc Actinolite HS11 | 7 | 0 | 0 | 1 | 6 | 1 | 8 | 8 | 0 | 9 | 8 | 1 | 8 | 8 | 5 | 9 | 2 | 9 | 2 | 1 | 9 | 8 | 3 | 0 | 9 | 2 | 9 | 2 | 1 | 9 | 9 | 8 | 8 | 7 |
| actinol2.spc Actinolite HS22. | 6 | 0 | 0 | 1 | 3 | 1 | 8 | 8 | 0 | 9 | 8 | 1 | 8 | 8 | 3 | 9 | 6 | 9 | 2 | 1 | 9 | 7 | 3 | 0 | 9 | 5 | 9 | 3 | 1 | 9 | 9 | 8 | 8 | 7 |
| actinol3.spc Actinolite HS31 | 6 | 3 | 1 | 4 | 9 | 1 | 9 | 6 | 0 | 9 | 6 | 5 | 6 | 9 | 1 | 9 | 1 | 9 | 1 | 1 | 9 | 7 | 0 | 0 | 9 | 1 | 9 | 4 | 3 | 8 | 8 | 7 | 2 | 2 |
| actinol4.spc Actinolite NMNH | 6 | 0 | 0 | 1 | 0 | 1 | 1 | 9 | 1 | 9 | 7 | 1 | 8 | 6 | 3 | 5 | 2 | 8 | 5 | 4 | 9 | 7 | 4 | 0 | 9 | 4 | 9 | 2 | 0 | 9 | 9 | 9 | 9 | 9 |
| actinol5.spc Actinolite NMNH | 4 | 0 | 0 | 2 | 4 | 4 | 9 | 8 | 0 | 8 | 4 | 4 | 5 | 8 | 0 | 8 | 6 | 8 | 2 | 2 | 8 | 5 | 1 | 1 | 9 | 3 | 9 | 4 | 2 | 7 | 7 | 6 | 5 | 4 |
| adularia.spc Adularia GDS57 | 1 | 2 | 2 | 2 | 4 | 3 | 4 | 4 | 7 | 4 | 3 | 4 | 3 | 5 | 2 | 4 | 4 | 3 | 6 | 4 | 3 | 2 | 2 | 4 | 5 | 6 | 5 | 7 | 6 | 4 | 5 | 5 | 6 | 6 |
| a-illite.spc Ammonio-Illite/Sm | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 4 | 8 | 1 | 8 | 4 | 5 | 9 | 1 | 9 | 8 | 0 | 9 | 9 | 1 | 4 | 6 | 7 | 3 | 2 | 4 | 5 | 7 | 1 | 1 | 0 | 0 | 1 |
| a-jarosi.spc Ammonio-jarosite | 9 | 8 | 8 | 9 | 9 | 5 | 8 | 0 | 1 | 6 | 8 | 4 | 7 | 9 | 0 | 9 | 0 | 1 | 8 | 7 | 0 | 0 | 0 | 6 | 4 | 2 | 7 | 0 | 4 | 6 | 5 | 1 | 2 | 4 |
| albite1.spc Albite GDS30 74- | 1 | 1 | 1 | 1 | 4 | 3 | 4 | 4 | 7 | 4 | 3 | 4 | 2 | 5 | 3 | 4 | 4 | 3 | 5 | 4 | 2 | 2 | 2 | 4 | 5 | 5 | 6 | 8 | 6 | 4 | 4 | 5 | 6 | 6 |
| albite2.spc Albite HS324.3B~ | 1 | 1 | 1 | 1 | 2 | 4 | 2 | 6 | 6 | 3 | 2 | 4 | 3 | 4 | 5 | 5 | 7 | 1 | 6 | 8 | 4 | 5 | 5 | 5 | 3 | 5 | 2 | 7 | 4 | 3 | 3 | 4 | 5 | 4 |
| albite3.spc Albite HS66.3B~~ | 2 | 2 | 2 | 2 | 4 | 3 | 5 | 5 | 6 | 3 | 3 | 5 | 2 | 5 | 4 | 4 | 5 | 3 | 5 | 6 | 3 | 3 | 3 | 4 | 5 | 5 | 5 | 7 | 6 | 3 | 4 | 4 | 5 | 5 |
| allanite.spc Allanite HS293.3 | 3 | 4 | 4 | 3 | 5 | 2 | 7 | 6 | 3 | 7 | 0 | 6 | 2 | 2 | 4 | 5 | 0 | 5 | 6 | 4 | 1 | 3 | 3 | 2 | 7 | 7 | 8 | 6 | 3 | 7 | 7 | 8 | 8 | 8 |
| almand1.spc Almandine HS1 | 5 | 9 | 9 | 8 | 0 | 9 | 8 | 9 | 9 | 0 | 0 | 1 | 0 | 8 | 1 | 7 | 7 | 5 | 2 | 2 | 4 | 1 | 1 | 2 | 6 | 8 | 6 | 9 | 9 | 6 | 7 | 7 | 7 | 8 |
| almand2.spc Almandine WS | 4 | 7 | 7 | 5 | 1 | 7 | 3 | 8 | 9 | 0 | 1 | 3 | 1 | 7 | 2 | 5 | 6 | 5 | 5 | 7 | 3 | 2 | 2 | 2 | 6 | 7 | 6 | 9 | 9 | 5 | 6 | 6 | 6 | 7 |
| almand3.spc Almandine WS | 6 | 8 | 8 | 7 | 1 | 8 | 7 | 8 | 9 | 0 | 0 | 3 | 0 | 7 | 3 | 6 | 5 | 5 | 4 | 4 | 4 | 3 | 2 | 2 | 6 | 7 | 7 | 6 | 9 | 5 | 6 | 6 | 7 | 7 |
| almand4.spc Almandine WS | 9 | 9 | 9 | 9 | 3 | 8 | 7 | 7 | 9 | 1 | 1 | 6 | 1 | 5 | 2 | 5 | 5 | 5 | 4 | 4 | 5 | 4 | 3 | 4 | 5 | 6 | 4 | 1 | 8 | 4 | 4 | 5 | 6 | 6 |
| almand5.spc Almandine WS | 6 | 8 | 8 | 7 | 2 | 8 | 7 | 8 | 9 | 0 | 0 | 5 | 0 | 7 | 1 | 6 | 5 | 5 | 4 | 5 | 3 | 3 | 3 | 2 | 6 | 7 | 5 | 5 | 9 | 3 | 5 | 6 | 6 | 6 |
| almand6.spc Almandine WS | 4 | 7 | 7 | 6 | 1 | 8 | 6 | 8 | 9 | 0 | 0 | 4 | 0 | 7 | 2 | 6 | 6 | 5 | 4 | 4 | 4 | 3 | 3 | 2 | 5 | 7 | 5 | 9 | 9 | 4 | 5 | 6 | 6 | 7 |
| amphibol.spc Amphibole NM | 5 | 0 | 0 | 1 | 2 | 1 | 4 | 8 | 1 | 8 | 6 | 2 | 6 | 7 | 3 | 7 | 1 | 8 | 5 | 5 | 8 | 5 | 1 | 1 | 9 | 3 | 9 | 4 | 1 | 8 | 8 | 8 | 8 | 8 |
| analcime.spc Analcime GDS | 1 | 2 | 3 | 2 | 3 | 3 | 8 | 5 | 8 | 2 | 7 | 9 | 7 | 6 | 7 | 7 | 2 | 6 | 4 | 3 | 6 | 5 | 5 | 8 | 2 | 1 | 3 | 8 | 7 | 5 | 1 | 2 | 3 | 2 |
| andalusi.spc Andalusite NMN | 0 | 9 | 9 | 8 | 0 | 9 | 0 | 8 | 3 | 6 | 3 | 3 | 3 | 5 | 3 | 4 | 4 | 2 | 4 | 6 | 1 | 1 | 3 | 4 | 4 | 6 | 5 | 2 | 1 | 5 | 5 | 6 | 6 | 7 |
| andesine.spc Andesine HS14 | 7 | 7 | 6 | 6 | 3 | 4 | 2 | 3 | 4 | 5 | 6 | 2 | 6 | 3 | 4 | 3 | 3 | 4 | 5 | 5 | 3 | 2 | 1 | 4 | 5 | 5 | 6 | 3 | 3 | 6 | 7 | 7 | 7 | 7 |
| andradi1.spc Andradite GDS | 7 | 8 | 7 | 8 | 3 | 7 | 2 | 5 | 5 | 6 | 3 | 3 | 4 | 4 | 5 | 3 | 4 | 4 | 4 | 3 | 1 | 2 | 3 | 5 | 3 | 4 | 4 | 2 | 3 | 6 | 6 | 7 | 7 | 7 |
| andradi2.spc Andradite HS11 | 9 | 8 | 8 | 9 | 5 | 8 | 1 | 6 | 1 | 7 | 5 | 2 | 6 | 3 | 5 | 3 | 6 | 6 | 1 | 1 | 1 | 2 | 3 | 8 | 3 | 1 | 7 | 0 | 1 | 7 | 7 | 7 | 7 | 5 |
| andradi3.spc Andradite NMN | 9 | 0 | 0 | 9 | 9 | 8 | 1 | 0 | 3 | 6 | 1 | 6 | 1 | 7 | 1 | 6 | 6 | 6 | 2 | 2 | 4 | 1 | 1 | 6 | 4 | 2 | 5 | 1 | 1 | 3 | 3 | 3 | 3 | 3 |
| andradi4.spc Andradite WS4 | 9 | 7 | 7 | 9 | 8 | 8 | 2 | 1 | 3 | 6 | 3 | 5 | 3 | 6 | 4 | 5 | 6 | 6 | 1 | 1 | 1 | 1 | 2 | 7 | 3 | 1 | 7 | 1 | 2 | 5 | 5 | 5 | 4 | 4 |
| andradi5.spc Andradite WS4 | 9 | 8 | 8 | 9 | 1 | 9 | 0 | 8 | 2 | 7 | 6 | 2 | 6 | 3 | 4 | 2 | 2 | 5 | 6 | 4 | 2 | 2 | 2 | 3 | 5 | 7 | 5 | 0 | 0 | 7 | 7 | 8 | 8 | 8 |
| anhydrit.spc Anhydrite GDS4 | 1 | 1 | 2 | 1 | 3 | 5 | 4 | 6 | 7 | 3 | 2 | 5 | 3 | 3 | 6 | 4 | 4 | 4 | 6 | 5 | 2 | 3 | 3 | 5 | 5 | 4 | 5 | 8 | 6 | 3 | 3 | 4 | 5 | 5 |
| annite1.spc Annite WS660~~ | 7 | 7 | 7 | 6 | 1 | 1 | 1 | 8 | 4 | 8 | 9 | 0 | 9 | 2 | 6 | 1 | 1 | 4 | 8 | 7 | 3 | 5 | 6 | 3 | 6 | 7 | 3 | 3 | 3 | 9 | 9 | 9 | 9 | 9 |
| annite2.spc Annite WS661~~ | 8 | 4 | 1 | 4 | 1 | 1 | 1 | 9 | 2 | 9 | 9 | 0 | 9 | 1 | 7 | 1 | 1 | 2 | 8 | 6 | 1 | 1 | 3 | 3 | 4 | 7 | 4 | 2 | 1 | 9 | 9 | 9 | 9 | 9 |
| anorthi1.spc Anorthite GDS2 | 1 | 2 | 3 | 2 | 3 | 4 | 2 | 4 | 5 | 4 | 3 | 4 | 3 | 5 | 2 | 4 | 4 | 3 | 6 | 6 | 3 | 2 | 3 | 4 | 5 | 5 | 5 | 7 | 4 | 4 | 4 | 5 | 6 | 6 |
| anorthi2.spc Anorthite HS201 | 2 | 3 | 4 | 3 | 6 | 4 | 6 | 4 | 8 | 2 | 3 | 3 | 4 | 5 | 2 | 5 | 3 | 4 | 5 | 3 | 3 | 2 | 3 | 3 | 6 | 6 | 6 | 8 | 8 | 5 | 5 | 6 | 6 | 7 |
| anorthi3.spc Anorthite HS349 | 3 | 2 | 2 | 3 | 8 | 2 | 7 | 1 | 8 | 3 | 5 | 3 | 5 | 3 | 5 | 3 | 7 | 7 | 4 | 5 | 6 | 6 | 7 | 3 | 2 | 8 | 1 | 8 | 8 | 6 | 6 | 6 | 5 | 5 |
| anthophi.spc Anthophyllite H | 8 | 8 | 7 | 7 | 9 | 5 | 9 | 1 | 1 | 8 | 1 | 7 | 1 | 9 | 0 | 8 | 8 | 9 | 2 | 2 | 9 | 5 | 0 | 0 | 9 | 2 | 9 | 2 | 3 | 5 | 3 | 2 | 1 | 2 |
| antigor1.spc Antigorite NMNH | 4 | 0 | 0 | 0 | 3 | 0 | 7 | 9 | 2 | 8 | 9 | 1 | 9 | 2 | 9 | 9 | 0 | 9 | 0 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 8 | 8 | 3 | 9 | 9 | 9 | 7 | 5 |
| antigor2.spc Antigorite NMNH | 5 | 0 | 0 | 0 | 1 | 0 | 2 | 9 | 2 | 8 | 8 | 1 | 8 | 2 | 8 | 8 | 0 | 9 | 1 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 9 | 6 | 2 | 9 | 9 | 8 | 8 | 6 |
| antigor3.spc Antigorite NMNH | 6 | 0 | 0 | 0 | 1 | 0 | 4 | 9 | 1 | 8 | 8 | 4 | 7 | 4 | 7 | 8 | 0 | 9 | 1 | 0 | 9 | 9 | 8 | 0 | 9 | 9 | 6 | 5 | 1 | 8 | 8 | 8 | 8 | 6 |
| antigor4.spc Antigorite NMNH | 4 | 0 | 0 | 0 | 2 | 1 | 7 | 8 | 2 | 7 | 7 | 3 | 6 | 5 | 5 | 7 | 1 | 9 | 3 | 1 | 8 | 8 | 5 | 0 | 9 | 8 | 9 | 6 | 2 | 8 | 8 | 8 | 7 | 7 |
| antigor5.spc Antigorite NMNH | 5 | 0 | 0 | 0 | 1 | 1 | 3 | 9 | 2 | 7 | 6 | 2 | 5 | 4 | 6 | 6 | 2 | 8 | 3 | 2 | 8 | 8 | 7 | 0 | 9 | 8 | 9 | 5 | 2 | 7 | 7 | 7 | 7 | 6 |
| antigor6.spc Antigorite NMNH | 4 | 0 | 1 | 1 | 2 | 1 | 4 | 8 | 3 | 6 | 5 | 3 | 5 | 5 | 5 | 7 | 1 | 8 | 2 | 2 | 8 | 7 | 5 | 1 | 9 | 8 | 8 | 5 | 2 | 7 | 7 | 7 | 7 | 6 |
| antigor7.spc Antigorite NMNH | 5 | 0 | 0 | 1 | 2 | 1 | 3 | 8 | 3 | 7 | 7 | 2 | 7 | 4 | 7 | 8 | 1 | 9 | 2 | 1 | 9 | 9 | 9 | 1 | 9 | 9 | 6 | 6 | 3 | 8 | 8 | 7 | 6 | 5 |
| arsenopy.spc Arsenopyrite H | 2 | 1 | 1 | 1 | 7 | 1 | 7 | 2 | 8 | 1 | 1 | 5 | 1 | 6 | 2 | 5 | 4 | 2 | 6 | 7 | 2 | 1 | 1 | 5 | 3 | 4 | 5 | 9 | 8 | 2 | 2 | 3 | 4 | 5 |
| a-smecti.spc Ammonio-Smec | 7 | 6 | 5 | 6 | 4 | 6 | 4 | 6 | 5 | 3 | 6 | 4 | 4 | 8 | 1 | 9 | 2 | 0 | 2 | 8 | 0 | 5 | 6 | 7 | 2 | 2 | 2 | 3 | 4 | 3 | 3 | 2 | 3 | 3 |
| augite1.spc Augite NMNH120 | 7 | 6 | 6 | 6 | 7 | 6 | 9 | 7 | 0 | 9 | 6 | 7 | 5 | 8 | 0 | 7 | 6 | 3 | 3 | 4 | 3 | 1 | 1 | 2 | 7 | 7 | 8 | 2 | 3 | 8 | 7 | 7 | 6 | 7 |
| augite2.spc Augite WS588~~ | 7 | 1 | 1 | 1 | 3 | 0 | 1 | 1 | 4 | 7 | 8 | 0 | 8 | 2 | 6 | 2 | 1 | 2 | 7 | 7 | 1 | 1 | 2 | 2 | 7 | 8 | 7 | 6 | 2 | 8 | 8 | 9 | 9 | 9 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| augite3.spc Augite WS592~~ | 8 | 6 | 2 | 7 | 6 | 7 | 9 | 8 | 0 | 8 | 5 | 6 | 6 | 8 | 0 | 8 | 7 | 6 | 3 | 3 | 5 | 3 | 4 | 2 | 6 | 7 | 7 | 2 | 3 | 8 | 7 | 6 | 5 | 5 |
| axinite.spc Axinite HS34.3B~ | 3 | 7 | 8 | 7 | 9 | 9 | 9 | 8 | 9 | 9 | 0 | 9 | 0 | 7 | 0 | 6 | 1 | 7 | 9 | 6 | 8 | 1 | 3 | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 9 |
| azurite.spc Azurite WS316~~ | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 9 | 9 | 9 | 9 | 2 | 0 | 0 | 8 | 9 | 0 | 1 | 9 | 9 | 0 | 3 | 0 | 9 | 0 | 1 | 0 | 9 | 8 | 5 | 2 | 2 |
| barite.spc Barite HS79.3B~~ | 6 | 9 | 9 | 8 | 2 | 8 | 1 | 6 | 3 | 5 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 6 | 4 | 3 | 2 | 3 | 4 | 5 | 5 | 6 | 1 | 2 | 5 | 5 | 6 | 7 | 7 |
| bassanit.spc Bassanite GDS | 3 | 4 | 4 | 4 | 5 | 4 | 6 | 4 | 8 | 1 | 7 | 9 | 6 | 2 | 9 | 8 | 5 | 6 | 2 | 2 | 5 | 3 | 3 | 9 | 2 | 0 | 4 | 6 | 7 | 2 | 1 | 2 | 1 | 1 |
| beryl1.spc Beryl GDS9 <150 | 4 | 5 | 6 | 2 | 8 | 0 | 0 | 0 | 3 | 5 | 2 | 6 | 2 | 5 | 4 | 2 | 5 | 5 | 7 | 6 | 4 | 4 | 4 | 5 | 4 | 4 | 4 | 5 | 1 | 4 | 1 | 4 | 5 | 5 |
| beryl2.spc Beryl HS180.3B~ | 3 | 1 | 1 | 0 | 8 | 0 | 0 | 0 | 2 | 6 | 1 | 8 | 2 | 3 | 6 | 1 | 4 | 5 | 8 | 7 | 5 | 6 | 6 | 7 | 2 | 3 | 2 | 6 | 0 | 4 | 0 | 2 | 4 | 3 |
| biotite.spc Biotite HS28.3B~ | 5 | 7 | 6 | 5 | 1 | 1 | 1 | 8 | 4 | 7 | 8 | 0 | 9 | 1 | 7 | 1 | 0 | 5 | 8 | 6 | 1 | 5 | 6 | 3 | 6 | 8 | 3 | 4 | 2 | 8 | 9 | 9 | 9 | 9 |
| bloedite.spc Bloedite GDS14 | 2 | 3 | 3 | 3 | 2 | 5 | 2 | 6 | 8 | 0 | 0 | 7 | 0 | 0 | 9 | 2 | 0 | 7 | 8 | 7 | 7 | 9 | 9 | 9 | 0 | 0 | 0 | 6 | 5 | 0 | 0 | 0 | 0 | 0 |
| bronzite.spc Bronzite HS9.3B | 8 | 7 | 7 | 8 | 9 | 1 | 9 | 0 | 0 | 8 | 0 | 9 | 0 | 0 | 8 | 0 | 0 | 1 | 9 | 8 | 1 | 0 | 1 | 1 | 8 | 8 | 8 | 1 | 1 | 0 | 0 | 0 | 2 | 3 |
| brookite.spc Brookite HS443 | 3 | 5 | 5 | 4 | 2 | 5 | 2 | 5 | 4 | 5 | 2 | 5 | 3 | 7 | 1 | 5 | 4 | 3 | 4 | 5 | 3 | 1 | 1 | 5 | 3 | 4 | 5 | 5 | 4 | 5 | 5 | 5 | 6 | 6 |
| brucite.spc Brucite HS247.3B | 5 | 3 | 3 | 3 | 8 | 2 | 7 | 1 | 4 | 3 | 1 | 9 | 0 | 9 | 0 | 8 | 7 | 9 | 0 | 0 | 9 | 8 | 8 | 0 | 9 | 9 | 9 | 5 | 7 | 1 | 1 | 0 | 0 | 0 |
| budding1.spc Buddingtonite | 7 | 7 | 7 | 8 | 1 | 8 | 1 | 7 | 4 | 4 | 7 | 4 | 3 | 9 | 0 | 9 | 0 | 0 | 9 | 8 | 0 | 0 | 1 | 2 | 7 | 7 | 7 | 1 | 3 | 3 | 4 | 1 | 3 | 5 |
| budding2.spc Buddingtonite | 6 | 6 | 6 | 6 | 2 | 7 | 2 | 7 | 5 | 3 | 5 | 5 | 1 | 9 | 0 | 9 | 0 | 1 | 8 | 7 | 0 | 0 | 1 | 3 | 6 | 7 | 6 | 3 | 4 | 2 | 3 | 2 | 3 | 4 |
| butlerit.spc Butlerite GDS25~ | 9 | 9 | 8 | 9 | 9 | 1 | 8 | 0 | 1 | 6 | 1 | 8 | 0 | 3 | 1 | 1 | 1 | 7 | 4 | 2 | 6 | 5 | 5 | 9 | 1 | 0 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| bytownit.spc Bytownite HS10 | 5 | 5 | 3 | 5 | 3 | 6 | 7 | 6 | 9 | 4 | 7 | 2 | 7 | 1 | 8 | 1 | 1 | 6 | 7 | 5 | 5 | 4 | 4 | 6 | 5 | 3 | 5 | 5 | 8 | 7 | 7 | 7 | 7 | 7 |
| calcite1.spc Calcite WS272~ | 2 | 2 | 2 | 1 | 5 | 2 | 3 | 3 | 7 | 3 | 2 | 7 | 1 | 3 | 8 | 7 | 7 | 8 | 3 | 2 | 8 | 9 | 8 | 0 | 8 | 9 | 0 | 7 | 6 | 3 | 2 | 4 | 3 | 4 |
| calcite2.spc Calcite HS48.3B | 2 | 4 | 4 | 3 | 6 | 4 | 6 | 3 | 7 | 2 | 4 | 4 | 4 | 3 | 8 | 7 | 7 | 8 | 3 | 1 | 8 | 9 | 8 | 0 | 8 | 9 | 1 | 8 | 7 | 4 | 4 | 5 | 3 | 5 |
| calcite3.spc Calcite CO2004 | 2 | 3 | 3 | 2 | 5 | 3 | 4 | 4 | 7 | 3 | 3 | 7 | 2 | 3 | 7 | 6 | 7 | 8 | 3 | 1 | 8 | 8 | 7 | 0 | 8 | 9 | 1 | 7 | 6 | 3 | 3 | 4 | 3 | 4 |
| carnall1.spc Carnallite NMNH | 5 | 8 | 9 | 7 | 5 | 7 | 5 | 4 | 9 | 0 | 9 | 9 | 9 | 0 | 9 | 1 | 8 | 6 | 0 | 0 | 0 | 0 | 0 | 9 | 3 | 0 | 8 | 3 | 8 | 1 | 1 | 0 | 0 | 0 |
| carnall2.spc Carnallite HS430 | 1 | 6 | 7 | 4 | 7 | 5 | 8 | 2 | 9 | 0 | 9 | 9 | 9 | 0 | 9 | 2 | 8 | 6 | 0 | 1 | 2 | 0 | 0 | 9 | 2 | 0 | 7 | 9 | 9 | 1 | 1 | 0 | 0 | 0 |
| cassiter.spc Cassiterite HS2 | 2 | 6 | 6 | 5 | 3 | 7 | 8 | 7 | 9 | 1 | 1 | 1 | 1 | 7 | 0 | 1 | 7 | 5 | 7 | 4 | 6 | 4 | 1 | 5 | 7 | 3 | 7 | 8 | 9 | 1 | 1 | 1 | 3 | 3 |
| c-black.spc Carbon_Black G | 0 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 8 | 1 | 7 | 9 | 1 | 8 | 8 | 0 | 6 | 0 | 0 | 0 | 9 | 0 | 0 | 9 | 0 | 2 | 0 | 9 | 6 | 1 | 1 | 2 | 0 | 3 |
| cchlore1.spc Clinochlore NM | 6 | 0 | 0 | 5 | 3 | 1 | 3 | 7 | 3 | 6 | 8 | 2 | 7 | 2 | 7 | 5 | 6 | 9 | 0 | 0 | 8 | 9 | 9 | 0 | 9 | 9 | 6 | 4 | 2 | 7 | 7 | 7 | 4 | 4 |
| cchlore2.spc Clinochlore_Fe | 7 | 0 | 0 | 0 | 2 | 0 | 2 | 9 | 2 | 9 | 9 | 0 | 9 | 1 | 7 | 2 | 2 | 8 | 2 | 1 | 7 | 6 | 7 | 1 | 4 | 9 | 1 | 4 | 1 | 9 | 9 | 9 | 9 | 9 |
| cchlore3.spc Clinochlore GDS | 6 | 0 | 0 | 0 | 3 | 0 | 4 | 8 | 2 | 8 | 9 | 1 | 8 | 1 | 8 | 3 | 5 | 9 | 1 | 0 | 8 | 8 | 8 | 1 | 7 | 9 | 1 | 5 | 2 | 8 | 8 | 8 | 8 | 8 |
| cchlore4.spc Clinochlore GDS | 7 | 1 | 2 | 4 | 7 | 2 | 3 | 2 | 4 | 2 | 8 | 4 | 7 | 2 | 8 | 5 | 6 | 9 | 0 | 0 | 8 | 8 | 7 | 1 | 8 | 9 | 5 | 4 | 4 | 3 | 2 | 2 | 1 | 2 |
| cchlore5.spc Clinochlore_Fe | 5 | 0 | 0 | 0 | 5 | 0 | 4 | 7 | 2 | 8 | 9 | 0 | 9 | 1 | 8 | 1 | 5 | 9 | 1 | 0 | 8 | 7 | 8 | 0 | 7 | 9 | 1 | 6 | 1 | 9 | 9 | 9 | 9 | 9 |
| cchlore6.spc Clinochlore_Fe | 6 | 0 | 0 | 0 | 2 | 0 | 3 | 9 | 1 | 9 | 9 | 0 | 9 | 1 | 8 | 2 | 2 | 8 | 1 | 0 | 8 | 7 | 8 | 1 | 7 | 9 | 2 | 5 | 1 | 9 | 9 | 9 | 9 | 9 |
| cchlore7.spc Clinochlore_Fe | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 2 | 8 | 8 | 0 | 8 | 2 | 6 | 2 | 4 | 7 | 3 | 1 | 6 | 6 | 5 | 1 | 7 | 9 | 3 | 3 | 1 | 9 | 9 | 9 | 9 | 9 |
| celestit.spc Celestite HS251 | 1 | 0 | 1 | 2 | 1 | 7 | 1 | 7 | 6 | 3 | 2 | 4 | 2 | 5 | 2 | 5 | 4 | 4 | 5 | 4 | 3 | 3 | 3 | 4 | 5 | 6 | 4 | 6 | 3 | 3 | 4 | 5 | 5 | 6 |
| celsian.spc Celsian HS200.3 | 3 | 4 | 4 | 3 | 3 | 5 | 2 | 5 | 5 | 3 | 6 | 4 | 5 | 1 | 8 | 1 | 6 | 6 | 4 | 7 | 5 | 6 | 7 | 6 | 2 | 5 | 1 | 6 | 4 | 4 | 4 | 3 | 4 | 4 |
| chabazit.spc Chabazite HS1 | 3 | 6 | 6 | 5 | 3 | 6 | 6 | 6 | 8 | 0 | 6 | 8 | 8 | 0 | 9 | 0 | 0 | 6 | 8 | 6 | 7 | 8 | 8 | 9 | 0 | 0 | 0 | 6 | 7 | 0 | 0 | 0 | 1 | 0 |
| chalcedo.spc Chalcedony CU | 4 | 5 | 5 | 5 | 1 | 6 | 1 | 7 | 5 | 2 | 4 | 6 | 5 | 3 | 7 | 5 | 8 | 3 | 1 | 2 | 1 | 0 | 1 | 4 | 7 | 5 | 8 | 4 | 3 | 1 | 2 | 2 | 2 | 3 |
| chalpy1.spc Chalcopyrite HS | 9 | 8 | 7 | 9 | 7 | 4 | 3 | 1 | 3 | 5 | 2 | 7 | 1 | 7 | 3 | 3 | 4 | 3 | 6 | 5 | 2 | 3 | 3 | 4 | 4 | 5 | 4 | 1 | 3 | 2 | 3 | 3 | 5 | 5 |
| chalpy2.spc Chalcopyrite S2 | 9 | 7 | 6 | 8 | 8 | 1 | 7 | 1 | 3 | 2 | 1 | 8 | 1 | 2 | 5 | 2 | 1 | 3 | 7 | 8 | 2 | 4 | 4 | 2 | 7 | 8 | 7 | 1 | 6 | 1 | 2 | 3 | 5 | 5 |
| chert.spc Chert ANP90-6D ( | 1 | 2 | 3 | 0 | 8 | 1 | 8 | 1 | 9 | 0 | 0 | 8 | 0 | 4 | 7 | 5 | 7 | 6 | 1 | 2 | 5 | 1 | 1 | 5 | 5 | 3 | 8 | 9 | 9 | 0 | 0 | 1 | 0 | 1 |
| chlorapa.spc Chlorapatite WS | 5 | 6 | 6 | 5 | 4 | 5 | 3 | 1 | 7 | 3 | 4 | 5 | 3 | 5 | 3 | 3 | 3 | 5 | 5 | 4 | 4 | 3 | 2 | 2 | 7 | 6 | 8 | 4 | 5 | 5 | 4 | 5 | 6 | 6 |
| chlorit1.spc Chlorite HS179.3 | 6 | 6 | 6 | 6 | 1 | 7 | 1 | 8 | 3 | 7 | 8 | 1 | 8 | 6 | 4 | 7 | 2 | 9 | 2 | 1 | 8 | 9 | 9 | 1 | 8 | 8 | 2 | 2 | 2 | 8 | 8 | 9 | 8 | 8 |
| chlorit2.spc Chlorite SMR-13 | 5 | 0 | 0 | 0 | 2 | 0 | 5 | 9 | 2 | 8 | 9 | 0 | 9 | 1 | 9 | 3 | 6 | 9 | 0 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 5 | 5 | 2 | 9 | 9 | 9 | 8 | 8 |
| chlorit3.spc Chlorite SMR-13 | 6 | 1 | 0 | 0 | 1 | 0 | 2 | 9 | 1 | 8 | 9 | 0 | 9 | 1 | 9 | 2 | 5 | 9 | 0 | 0 | 9 | 9 | 9 | 0 | 8 | 9 | 2 | 3 | 1 | 9 | 9 | 9 | 8 | 8 |
| chlorit4.spc Chlorite SMR-13 | 7 | 2 | 1 | 3 | 1 | 1 | 2 | 9 | 2 | 8 | 8 | 1 | 8 | 1 | 8 | 5 | 4 | 9 | 1 | 0 | 8 | 8 | 7 | 0 | 9 | 9 | 6 | 3 | 1 | 8 | 8 | 8 | 8 | 8 |
| chlorit5.spc Chlorite SMR-13 | 8 | 4 | 1 | 4 | 1 | 1 | 1 | 9 | 2 | 8 | 8 | 1 | 8 | 2 | 8 | 3 | 5 | 9 | 1 | 0 | 8 | 8 | 7 | 1 | 8 | 9 | 3 | 2 | 1 | 8 | 8 | 8 | 8 | 8 |
| chlorit6.spc Chlorite SMR-13 | 8 | 6 | 6 | 6 | 1 | 1 | 2 | 9 | 2 | 7 | 7 | 1 | 7 | 2 | 6 | 5 | 3 | 8 | 1 | 1 | 7 | 7 | 7 | 1 | 8 | 8 | 4 | 2 | 2 | 8 | 8 | 8 | 8 | 8 |
| chromite.spc Chromite HS28 | 4 | 6 | 7 | 6 | 1 | 7 | 1 | 7 | 2 | 5 | 0 | 9 | 0 | 7 | 0 | 1 | 8 | 6 | 4 | 6 | 7 | 2 | 4 | 1 | 5 | 8 | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 1 |
| chrysoco.spc Chrysocolla HS | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 9 | 8 | 7 | 9 | 0 | 9 | 0 | 5 | 7 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 3 | 8 | 0 | 9 | 8 | 6 | 2 | 2 |
| chrysoti.spc Chrysotile HS32 | 1 | 1 | 3 | 1 | 5 | 2 | 4 | 3 | 7 | 2 | 1 | 6 | 2 | 5 | 5 | 6 | 2 | 7 | 4 | 3 | 7 | 8 | 8 | 1 | 8 | 8 | 4 | 8 | 7 | 2 | 3 | 3 | 4 | 4 |
| cinnabar.spc Cinnabar HS13 | 1 | 9 | 9 | 9 | 2 | 9 | 1 | 6 | 3 | 5 | 4 | 3 | 3 | 5 | 4 | 5 | 3 | 2 | 2 | 3 | 1 | 4 | 4 | 4 | 5 | 7 | 4 | 0 | 2 | 5 | 6 | 6 | 7 | 7 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| clintoni.spc Clintonite NMNH | 7 | 3 | 2 | 5 | 2 | 3 | 6 | 7 | 2 | 7 | 1 | 6 | 1 | 3 | 6 | 3 | 6 | 9 | 1 | 0 | 9 | 0 | 5 | 1 | 8 | 8 | 8 | 3 | 3 | 7 | 7 | 7 | 2 | 4 |
| cobaltit.spc Cobaltite HS264. | 0 | 4 | 5 | 2 | 3 | 5 | 3 | 5 | 7 | 2 | 2 | 6 | 2 | 6 | 2 | 4 | 3 | 3 | 6 | 4 | 3 | 2 | 2 | 3 | 5 | 7 | 4 | 8 | 7 | 3 | 3 | 5 | 5 | 6 |
| colemani.spc Colemanite GD | 2 | 3 | 3 | 3 | 5 | 3 | 8 | 4 | 9 | 0 | 0 | 1 | 0 | 8 | 7 | 9 | 0 | 0 | 8 | 8 | 0 | 2 | 4 | 9 | 0 | 0 | 2 | 8 | 8 | 0 | 0 | 0 | 0 | 0 |
| cookeit1.spc Cookeite CAr-1. | 7 | 6 | 6 | 6 | 5 | 5 | 3 | 4 | 5 | 1 | 5 | 1 | 5 | 6 | 0 | 5 | 9 | 2 | 9 | 8 | 2 | 9 | 9 | 7 | 0 | 5 | 0 | 3 | 5 | 1 | 2 | 1 | 1 | 1 |
| cookeit2.spc Cookeite CAr-1. | 6 | 5 | 4 | 5 | 5 | 4 | 6 | 3 | 5 | 2 | 5 | 1 | 4 | 6 | 1 | 4 | 9 | 1 | 8 | 8 | 3 | 7 | 9 | 6 | 0 | 4 | 0 | 4 | 6 | 1 | 2 | 2 | 1 | 2 |
| cookeit3.spc Cookeite CAr-1. | 6 | 6 | 6 | 6 | 3 | 4 | 3 | 5 | 6 | 4 | 2 | 3 | 2 | 4 | 3 | 6 | 8 | 3 | 7 | 6 | 3 | 5 | 6 | 5 | 2 | 5 | 2 | 3 | 5 | 3 | 4 | 4 | 4 | 4 |
| copiapit.spc Copiapite GDS2 | 9 | 8 | 8 | 9 | 9 | 1 | 0 | 0 | 2 | 0 | 0 | 9 | 0 | 0 | 8 | 0 | 0 | 6 | 8 | 7 | 6 | 8 | 8 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| coquimbi.spc Coquimbite GD | 8 | 5 | 7 | 6 | 1 | 4 | 0 | 1 | 7 | 0 | 0 | 9 | 0 | 1 | 7 | 1 | 0 | 3 | 8 | 8 | 4 | 6 | 6 | 9 | 1 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 |
| cordieri.spc Cordierite HS346 | 4 | 5 | 5 | 5 | 8 | 6 | 8 | 3 | 4 | 5 | 2 | 6 | 2 | 6 | 4 | 6 | 7 | 2 | 2 | 8 | 4 | 6 | 5 | 5 | 3 | 4 | 4 | 5 | 7 | 3 | 2 | 3 | 3 | 3 |
| corrensi.spc Corrensite CorW | 8 | 6 | 4 | 7 | 0 | 7 | 1 | 8 | 2 | 7 | 7 | 2 | 7 | 2 | 6 | 2 | 3 | 7 | 2 | 3 | 6 | 5 | 5 | 4 | 5 | 5 | 5 | 1 | 1 | 8 | 8 | 8 | 8 | 8 |
| corundum.spc Corundum HS | 2 | 0 | 4 | 2 | 0 | 7 | 0 | 8 | 3 | 5 | 0 | 9 | 0 | 7 | 0 | 4 | 3 | 5 | 7 | 6 | 4 | 4 | 4 | 6 | 3 | 3 | 4 | 4 | 2 | 1 | 0 | 1 | 1 | 2 |
| covellit.spc Covellite HS477.2 | 3 | 5 | 4 | 7 | 0 | 9 | 0 | 8 | 5 | 4 | 0 | 8 | 1 | 4 | 1 | 2 | 5 | 2 | 6 | 2 | 1 | 0 | 1 | 4 | 3 | 7 | 3 | 2 | 1 | 2 | 2 | 3 | 5 | 6 |
| cptilol1.spc Clinoptilolite GDS | 8 | 7 | 6 | 7 | 2 | 7 | 4 | 7 | 5 | 2 | 6 | 8 | 7 | 1 | 9 | 2 | 2 | 6 | 4 | 3 | 6 | 6 | 6 | 8 | 1 | 1 | 2 | 1 | 5 | 4 | 2 | 2 | 3 | 2 |
| cptilol2.spc Clinoptilolite GDS | 8 | 6 | 6 | 7 | 6 | 6 | 6 | 5 | 5 | 1 | 5 | 8 | 6 | 1 | 9 | 1 | 1 | 7 | 4 | 3 | 6 | 6 | 6 | 8 | 1 | 1 | 2 | 2 | 6 | 2 | 1 | 1 | 3 | 2 |
| cronsted.spc Cronstedtite M3 | 8 | 7 | 6 | 7 | 1 | 1 | 1 | 8 | 2 | 8 | 9 | 0 | 9 | 3 | 2 | 3 | 1 | 1 | 7 | 3 | 1 | 7 | 8 | 2 | 2 | 9 | 0 | 1 | 1 | 9 | 9 | 9 | 9 | 9 |
| cummingt.spc Cummingtonit | 5 | 2 | 4 | 3 | 9 | 1 | 9 | 1 | 0 | 8 | 8 | 1 | 8 | 7 | 2 | 7 | 6 | 7 | 2 | 1 | 6 | 6 | 7 | 6 | 2 | 8 | 1 | 8 | 9 | 8 | 8 | 8 | 8 | 8 |
| cuprite.spc Cuprite HS127.3E | 1 | 2 | 5 | 6 | 0 | 9 | 0 | 9 | 3 | 6 | 6 | 3 | 5 | 5 | 2 | 6 | 2 | 5 | 3 | 3 | 4 | 1 | 1 | 4 | 5 | 4 | 6 | 0 | 0 | 6 | 6 | 6 | 7 | 7 |
| czoisite.spc Clinozoisite HS2 | 7 | 7 | 8 | 8 | 3 | 8 | 2 | 3 | 2 | 6 | 8 | 3 | 5 | 5 | 4 | 3 | 5 | 8 | 3 | 2 | 7 | 9 | 9 | 0 | 6 | 9 | 0 | 1 | 2 | 6 | 6 | 6 | 5 | 7 |
| datolit1.spc Datolite HS442.3 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 3 | 9 | 6 | 9 | 0 | 9 | 9 | 1 | 7 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 6 | 5 | 5 | 2 | 1 | 1 | 0 | 0 |
| datolit2.spc Datolite SU51399 | 1 | 1 | 2 | 1 | 4 | 2 | 3 | 4 | 5 | 2 | 2 | 9 | 5 | 9 | 0 | 9 | 8 | 1 | 7 | 0 | 0 | 0 | 0 | 9 | 8 | 0 | 5 | 7 | 4 | 2 | 2 | 2 | 0 | 0 |
| desertv1.spc Desert_Varnish | 6 | 9 | 9 | 8 | 0 | 8 | 0 | 9 | 2 | 6 | 6 | 3 | 6 | 4 | 6 | 4 | 4 | 6 | 6 | 7 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 0 | 0 | 6 | 7 | 6 | 7 | 6 |
| desertv2.spc Desert_Varnish | 2 | 2 | 5 | 4 | 0 | 8 | 0 | 9 | 1 | 8 | 8 | 0 | 8 | 3 | 6 | 6 | 7 | 1 | 0 | 1 | 0 | 6 | 8 | 6 | 1 | 8 | 0 | 2 | 0 | 8 | 8 | 8 | 9 | 8 |
| desertv3.spc Desert_Varnish | 4 | 7 | 7 | 6 | 0 | 8 | 0 | 8 | 1 | 8 | 8 | 1 | 8 | 1 | 8 | 1 | 7 | 2 | 1 | 6 | 2 | 4 | 4 | 6 | 4 | 3 | 4 | 1 | 0 | 8 | 8 | 8 | 8 | 8 |
| diaspore.spc Diaspore HS416 | 6 | 7 | 7 | 7 | 0 | 8 | 0 | 9 | 3 | 4 | 0 | 9 | 0 | 8 | 0 | 3 | 7 | 5 | 5 | 6 | 5 | 5 | 5 | 8 | 1 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| dickite1.spc Dickite NMNH10 | 4 | 5 | 5 | 5 | 4 | 5 | 7 | 5 | 7 | 3 | 2 | 8 | 1 | 9 | 0 | 9 | 9 | 0 | 9 | 9 | 9 | 8 | 7 | 7 | 1 | 1 | 6 | 5 | 5 | 3 | 1 | 2 | 1 | 1 |
| dickite2.spc Dickite NMNH46 | 2 | 5 | 6 | 3 | 5 | 5 | 5 | 4 | 6 | 3 | 3 | 6 | 3 | 9 | 1 | 8 | 9 | 1 | 9 | 9 | 7 | 6 | 5 | 6 | 3 | 2 | 5 | 6 | 5 | 3 | 3 | 3 | 2 | 3 |
| diopsid1.spc Diopside HS317 | 6 | 1 | 0 | 4 | 8 | 7 | 9 | 8 | 1 | 7 | 3 | 5 | 4 | 7 | 1 | 7 | 5 | 8 | 3 | 2 | 8 | 4 | 0 | 1 | 9 | 4 | 9 | 7 | 9 | 7 | 7 | 7 | 7 | 7 |
| diopsid2.spc Diopside HS15. | 6 | 2 | 1 | 2 | 8 | 0 | 8 | 0 | 3 | 7 | 8 | 1 | 8 | 3 | 6 | 3 | 3 | 6 | 6 | 4 | 5 | 3 | 1 | 2 | 7 | 7 | 8 | 9 | 8 | 8 | 8 | 8 | 9 | 9 |
| diopsid3.spc Diopside NMNH | 4 | 3 | 2 | 3 | 8 | 0 | 8 | 0 | 1 | 7 | 6 | 1 | 6 | 7 | 1 | 6 | 6 | 6 | 3 | 3 | 4 | 3 | 2 | 2 | 7 | 6 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| dipyre.spc Dipyre BM1959-50 | 4 | 4 | 4 | 4 | 2 | 4 | 1 | 4 | 4 | 5 | 5 | 4 | 5 | 2 | 7 | 3 | 5 | 6 | 5 | 7 | 6 | 6 | 7 | 5 | 5 | 7 | 3 | 5 | 3 | 5 | 6 | 6 | 7 | 5 |
| dolomit1.spc Dolomite HS102 | 0 | 1 | 2 | 0 | 7 | 2 | 7 | 2 | 7 | 3 | 2 | 6 | 2 | 6 | 5 | 7 | 4 | 8 | 1 | 1 | 8 | 5 | 4 | 0 | 9 | 9 | 9 | 9 | 8 | 4 | 3 | 4 | 2 | 4 |
| dolomit2.spc Dolomite COD2 | 3 | 5 | 5 | 4 | 7 | 4 | 7 | 3 | 5 | 5 | 4 | 5 | 3 | 6 | 6 | 6 | 5 | 7 | 2 | 1 | 7 | 5 | 4 | 1 | 9 | 9 | 8 | 7 | 7 | 5 | 5 | 6 | 4 | 5 |
| dumortie.spc Dumortierite HS | 0 | 8 | 8 | 6 | 0 | 9 | 0 | 8 | 4 | 4 | 1 | 8 | 1 | 8 | 1 | 8 | 8 | 5 | 8 | 8 | 6 | 4 | 5 | 6 | 4 | 3 | 5 | 3 | 2 | 2 | 1 | 2 | 1 | 2 |
| elbaite1.spc Elbaite NMNH94 | 6 | 8 | 8 | 4 | 0 | 6 | 2 | 9 | 8 | 4 | 7 | 3 | 8 | 9 | 0 | 7 | 9 | 1 | 9 | 9 | 9 | 0 | 8 | 7 | 5 | 0 | 9 | 2 | 3 | 6 | 5 | 3 | 0 | 0 |
| elbaite2.spc Elbaite NMNH94 | 5 | 7 | 7 | 3 | 0 | 6 | 2 | 8 | 8 | 4 | 7 | 4 | 8 | 9 | 0 | 7 | 9 | 1 | 9 | 9 | 9 | 0 | 6 | 6 | 6 | 0 | 9 | 3 | 4 | 6 | 5 | 3 | 1 | 1 |
| elbaite3.spc Elbaite NMNH94 | 2 | 5 | 6 | 2 | 2 | 4 | 2 | 6 | 6 | 4 | 5 | 3 | 5 | 8 | 1 | 5 | 9 | 2 | 9 | 9 | 8 | 0 | 5 | 5 | 6 | 1 | 9 | 6 | 4 | 5 | 5 | 4 | 3 | 3 |
| elbaite3.spc Elbaite NMNH94 | 2 | 5 | 6 | 2 | 2 | 4 | 2 | 6 | 6 | 4 | 5 | 3 | 5 | 8 | 1 | 5 | 9 | 2 | 9 | 9 | 8 | 0 | 5 | 5 | 6 | 1 | 9 | 6 | 4 | 5 | 5 | 4 | 3 | 3 |
| endellit.spc Endellite GDS16 | 7 | 8 | 7 | 7 | 6 | 7 | 7 | 5 | 5 | 1 | 5 | 7 | 5 | 9 | 7 | 9 | 9 | 0 | 9 | 9 | 7 | 8 | 8 | 8 | 1 | 1 | 2 | 2 | 7 | 1 | 1 | 1 | 0 | 0 |
| enstatit.spc Enstatite NMNH | 5 | 4 | 2 | 6 | 9 | 5 | 8 | 1 | 2 | 6 | 0 | 8 | 0 | 2 | 6 | 1 | 1 | 6 | 7 | 5 | 6 | 4 | 4 | 2 | 8 | 7 | 7 | 4 | 3 | 1 | 1 | 3 | 6 | 6 |
| epidote1.spc Epidote GDS26 | 9 | 1 | 0 | 9 | 0 | 9 | 4 | 9 | 0 | 8 | 9 | 0 | 8 | 4 | 4 | 4 | 7 | 9 | 1 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 0 | 0 | 0 | 8 | 8 | 8 | 7 | 8 |
| epidote2.spc Epidote GDS26 | 9 | 1 | 1 | 8 | 1 | 8 | 3 | 8 | 2 | 6 | 7 | 2 | 6 | 5 | 3 | 4 | 4 | 8 | 2 | 2 | 8 | 9 | 9 | 0 | 9 | 9 | 0 | 0 | 2 | 6 | 7 | 7 | 6 | 7 |
| epidote3.spc Epidote HS328. | 9 | 2 | 0 | 8 | 0 | 9 | 3 | 8 | 1 | 7 | 8 | 1 | 7 | 3 | 4 | 4 | 5 | 9 | 1 | 1 | 9 | 9 | 9 | 0 | 9 | 9 | 0 | 1 | 1 | 7 | 7 | 8 | 6 | 8 |
| epsomite.spc Epsomite GDS | 0 | 1 | 1 | 0 | 8 | 1 | 8 | 1 | 9 | 0 | 7 | 0 | 9 | 0 | 9 | 0 | 0 | 8 | 8 | 7 | 8 | 9 | 9 | 9 | 0 | 0 | 0 | 9 | 9 | 0 | 0 | 0 | 0 | 0 |
| erionitm.spc Erionite+Merlino | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 6 | 1 | 5 | 7 | 9 | 7 | 1 | 9 | 1 | 3 | 6 | 3 | 6 | 6 | 6 | 5 | 8 | 1 | 1 | 3 | 0 | 3 | 2 | 1 | 1 | 2 | 2 |
| erionito.spc Erionite+Offretite | 7 | 6 | 5 | 6 | 4 | 5 | 6 | 5 | 8 | 1 | 6 | 8 | 6 | 1 | 9 | 1 | 1 | 6 | 5 | 4 | 6 | 7 | 7 | 8 | 1 | 1 | 1 | 4 | 7 | 1 | 1 | 1 | 2 | 2 |
| eugsteri.spc Eugsterite GDS | 3 | 4 | 4 | 4 | 3 | 5 | 3 | 5 | 7 | 2 | 4 | 5 | 4 | 1 | 8 | 2 | 1 | 3 | 7 | 6 | 2 | 4 | 4 | 8 | 2 | 2 | 3 | 5 | 5 | 2 | 3 | 2 | 4 | 3 |
| europium.spc Europium_Oxid | 4 | 2 | 2 | 1 | 5 | 2 | 4 | 2 | 7 | 2 | 1 | 8 | 1 | 1 | 7 | 0 | 7 | 1 | 9 | 8 | 1 | 5 | 5 | 7 | 2 | 3 | 2 | 5 | 6 | 2 | 1 | 1 | 2 | 3 |
| fassaite.spc Fassaite HS118 | 8 | 3 | 1 | 6 | 1 | 4 | 1 | 8 | 2 | 7 | 5 | 3 | 5 | 5 | 4 | 5 | 4 | 7 | 2 | 1 | 5 | 5 | 6 | 3 | 6 | 7 | 4 | 1 | 1 | 7 | 7 | 7 | 7 | 7 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ferrihyd.spc Ferrihydrite GDS | 8 | 9 | 9 | 9 | 0 | 9 | 7 | 9 | 0 | 9 | 7 | 8 | 7 | 1 | 7 | 1 | 2 | 7 | 3 | 2 | 6 | 5 | 5 | 7 | 2 | 2 | 4 | 0 | 0 | 9 | 8 | 8 | 8 | 7 |
| fluorapa.spc Fluorapatite WS | 5 | 5 | 6 | 5 | 6 | 4 | 4 | 1 | 7 | 3 | 3 | 4 | 3 | 5 | 3 | 4 | 3 | 3 | 6 | 5 | 2 | 2 | 2 | 4 | 5 | 5 | 6 | 4 | 6 | 3 | 4 | 5 | 6 | 6 |
| galena1.spc Galena HS37.3~ | 0 | 1 | 2 | 0 | 7 | 4 | 6 | 2 | 8 | 2 | 1 | 6 | 1 | 6 | 4 | 5 | 2 | 4 | 7 | 5 | 2 | 1 | 1 | 3 | 5 | 6 | 7 | 9 | 8 | 2 | 3 | 4 | 5 | 6 |
| galena2.spc Galena S102-17 | 0 | 0 | 1 | 0 | 7 | 2 | 7 | 1 | 8 | 2 | 6 | 2 | 1 | 7 | 0 | 8 | 2 | 6 | 8 | 1 | 5 | 2 | 1 | 4 | 4 | 7 | 3 | 9 | 8 | 2 | 2 | 3 | 4 | 5 |
| galena3.spc Galena S102-1B | 0 | 0 | 1 | 0 | 6 | 2 | 6 | 2 | 6 | 1 | 2 | 1 | 1 | 8 | 0 | 7 | 4 | 2 | 5 | 7 | 5 | 0 | 1 | 2 | 4 | 5 | 8 | 9 | 8 | 2 | 2 | 3 | 4 | 6 |
| galena4.spc Galena S105-2~ | 0 | 0 | 1 | 0 | 5 | 2 | 6 | 1 | 9 | 1 | 0 | 0 | 4 | 2 | 6 | 2 | 7 | 2 | 7 | 6 | 1 | 4 | 3 | 3 | 3 | 7 | 4 | 9 | 8 | 1 | 1 | 3 | 5 | 5 |
| galena5.spc Galena S26-39~ | 0 | 1 | 2 | 0 | 7 | 3 | 8 | 1 | 8 | 1 | 1 | 1 | 4 | 7 | 0 | 8 | 0 | 5 | 2 | 0 | 1 | 1 | 2 | 3 | 6 | 7 | 7 | 9 | 8 | 2 | 2 | 3 | 5 | 6 |
| galena6.spc Galena S26-40~ | 0 | 1 | 1 | 0 | 7 | 3 | 7 | 1 | 8 | 1 | 1 | 1 | 1 | 4 | 0 | 3 | 5 | 2 | 3 | 1 | 1 | 1 | 4 | 4 | 4 | 7 | 2 | 9 | 8 | 2 | 3 | 3 | 5 | 6 |
| gaylussi.spc Gaylussite NMN | 5 | 5 | 3 | 6 | 1 | 8 | 4 | 8 | 9 | 0 | 8 | 9 | 0 | 1 | 7 | 0 | 0 | 6 | 9 | 8 | 6 | 8 | 8 | 9 | 1 | 1 | 1 | 5 | 8 | 0 | 0 | 0 | 0 | 0 |
| gibbsit1.spc Gibbsite HS423. | 6 | 7 | 7 | 7 | 2 | 7 | 4 | 6 | 4 | 0 | 9 | 6 | 9 | 9 | 0 | 8 | 9 | 9 | 0 | 0 | 8 | 0 | 0 | 1 | 8 | 3 | 9 | 3 | 3 | 0 | 0 | 0 | 0 | 0 |
| gibbsit2.spc Gibbsite WS214 | 8 | 8 | 8 | 8 | 2 | 7 | 2 | 6 | 4 | 1 | 9 | 3 | 8 | 8 | 2 | 7 | 9 | 8 | 0 | 0 | 7 | 0 | 0 | 2 | 5 | 4 | 8 | 1 | 3 | 1 | 1 | 1 | 0 | 1 |
| glauconi.spc Glauconite HS3 | 7 | 0 | 0 | 0 | 8 | 0 | 8 | 1 | 7 | 6 | 8 | 0 | 8 | 1 | 8 | 0 | 0 | 8 | 7 | 5 | 8 | 5 | 6 | 0 | 8 | 8 | 9 | 9 | 8 | 8 | 8 | 9 | 9 | 9 |
| glaucoph.spc Glaucophane H | 3 | 0 | 1 | 1 | 0 | 8 | 0 | 9 | 0 | 9 | 8 | 1 | 8 | 6 | 6 | 6 | 8 | 9 | 1 | 1 | 9 | 9 | 9 | 0 | 9 | 9 | 9 | 1 | 0 | 8 | 8 | 8 | 7 | 7 |
| goethit1.spc Goethite WS222 | 9 | 9 | 9 | 9 | 8 | 9 | 8 | 7 | 0 | 9 | 1 | 7 | 1 | 2 | 6 | 2 | 4 | 6 | 3 | 3 | 6 | 5 | 5 | 7 | 2 | 2 | 3 | 0 | 0 | 7 | 6 | 7 | 7 | 5 |
| goethit2.spc Goethite HS36.3 | 7 | 9 | 8 | 8 | 8 | 5 | 7 | 2 | 2 | 6 | 4 | 4 | 4 | 3 | 5 | 5 | 1 | 4 | 8 | 1 | 4 | 2 | 1 | 5 | 3 | 3 | 6 | 2 | 4 | 6 | 7 | 7 | 8 | 8 |
| goethit3.spc Goethite WS219 | 9 | 9 | 9 | 9 | 8 | 9 | 9 | 7 | 0 | 9 | 0 | 9 | 0 | 5 | 5 | 5 | 7 | 6 | 3 | 7 | 6 | 6 | 6 | 7 | 2 | 2 | 2 | 0 | 0 | 7 | 6 | 5 | 5 | 4 |
| goethit4.spc Goethite WS220 | 9 | 9 | 9 | 9 | 8 | 9 | 8 | 5 | 0 | 9 | 1 | 8 | 1 | 2 | 5 | 2 | 4 | 7 | 2 | 2 | 6 | 5 | 5 | 6 | 3 | 2 | 4 | 0 | 0 | 7 | 7 | 6 | 6 | 5 |
| grossul1.spc Grossular HS11 | 4 | 1 | 1 | 5 | 4 | 6 | 4 | 3 | 3 | 4 | 1 | 7 | 3 | 8 | 4 | 7 | 9 | 7 | 0 | 1 | 6 | 8 | 9 | 5 | 0 | 8 | 0 | 5 | 5 | 4 | 2 | 3 | 1 | 1 |
| grossul2.spc Grossular NMN | 8 | 9 | 9 | 9 | 2 | 9 | 4 | 8 | 9 | 4 | 0 | 8 | 0 | 3 | 4 | 2 | 6 | 5 | 2 | 5 | 3 | 4 | 5 | 6 | 1 | 4 | 1 | 1 | 9 | 7 | 7 | 8 | 7 | 7 |
| grossul3.spc Grossular WS4 | 3 | 4 | 5 | 3 | 5 | 4 | 5 | 5 | 8 | 4 | 1 | 5 | 1 | 6 | 4 | 5 | 7 | 5 | 3 | 5 | 4 | 5 | 4 | 5 | 3 | 6 | 3 | 7 | 7 | 5 | 5 | 6 | 5 | 5 |
| grossul4.spc Grossular WS4 | 3 | 4 | 5 | 4 | 7 | 5 | 5 | 2 | 7 | 3 | 2 | 6 | 1 | 6 | 2 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 4 | 4 | 5 | 5 | 4 | 6 | 5 | 3 | 3 | 3 | 4 | 4 |
| grossul5.spc Grossular WS4 | 3 | 6 | 6 | 5 | 4 | 6 | 4 | 4 | 9 | 2 | 1 | 7 | 0 | 5 | 3 | 5 | 6 | 4 | 5 | 6 | 2 | 4 | 4 | 5 | 2 | 4 | 3 | 8 | 9 | 6 | 6 | 7 | 7 | 7 |
| gypsum1.spc Gypsum HS33 | 0 | 1 | 2 | 1 | 6 | 2 | 7 | 3 | 9 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 9 | 1 | 1 | 3 | 0 | 0 | 2 | 9 | 0 | 0 | 3 | 9 | 9 | 1 | 1 | 1 | 0 | 0 |
| gypsum2.spc Gypsum SU22 | 1 | 3 | 4 | 2 | 6 | 3 | 5 | 3 | 9 | 0 | 9 | 9 | 9 | 0 | 9 | 8 | 8 | 1 | 2 | 3 | 0 | 1 | 2 | 9 | 2 | 0 | 3 | 8 | 8 | 2 | 2 | 1 | 1 | 1 |
| h2o-ice.spc H2O-Ice GDS136 | ? | ? | ? | ? | ? | ? | ? | ? | 9 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 | 8 | 9 | 8 | 9 | 9 | 9 | 9 | 0 | 0 | 0 | ? | ? | 0 | 0 | 0 | 0 | 0 |
| halite.spc Halite HS433.3B~~ | 1 | 3 | 3 | 2 | 4 | 3 | 3 | 2 | 6 | 3 | 3 | 3 | 3 | 3 | 5 | 4 | 3 | 3 | 6 | 5 | 2 | 3 | 3 | 4 | 5 | 5 | 5 | 7 | 6 | 3 | 4 | 4 | 6 | 6 |
| halloys1.spc Halloysite NMN | 3 | 5 | 5 | 4 | 6 | 5 | 8 | 3 | 8 | 1 | 6 | 8 | 6 | 9 | 7 | 9 | 9 | 0 | 9 | 9 | 7 | 8 | 8 | 8 | 1 | 1 | 2 | 6 | 8 | 1 | 0 | 1 | 0 | 0 |
| halloys2.spc Halloysite NMN | 2 | 4 | 4 | 3 | 6 | 4 | 7 | 4 | 8 | 1 | 4 | 8 | 4 | 8 | 7 | 8 | 9 | 0 | 8 | 9 | 6 | 7 | 7 | 8 | 1 | 1 | 4 | 7 | 7 | 1 | 1 | 1 | 1 | 1 |
| halloys3.spc Halloysite CM13 | 4 | 6 | 6 | 5 | 7 | 4 | 7 | 4 | 5 | 1 | 5 | 8 | 6 | 8 | 7 | 8 | 9 | 0 | 9 | 9 | 6 | 7 | 7 | 7 | 2 | 2 | 4 | 5 | 7 | 1 | 1 | 1 | 1 | 1 |
| halloys4.spc Halloysite KLH5 | 2 | 4 | 5 | 3 | 5 | 5 | 7 | 4 | 8 | 1 | 6 | 8 | 7 | 6 | 8 | 8 | 9 | 0 | 8 | 9 | 6 | 7 | 7 | 8 | 1 | 1 | 3 | 7 | 7 | 1 | 1 | 1 | 0 | 0 |
| halloys5.spc Halloysite+Kaol | 4 | 6 | 5 | 4 | 6 | 4 | 6 | 4 | 5 | 2 | 4 | 8 | 4 | 9 | 5 | 9 | 9 | 0 | 9 | 9 | 7 | 8 | 7 | 8 | 1 | 1 | 4 | 6 | 6 | 2 | 1 | 1 | 0 | 0 |
| hapatite.spc Hydroxyl-Apatite | 7 | 8 | 8 | 8 | 0 | 9 | 0 | 9 | 1 | 8 | 7 | 1 | 7 | 2 | 6 | 3 | 1 | 3 | 5 | 5 | 2 | 3 | 4 | 6 | 3 | 3 | 4 | 0 | 0 | 8 | 8 | 8 | 8 | 8 |
| hectori1.spc Hectorite SHCa- | 3 | 6 | 6 | 4 | 4 | 5 | 4 | 5 | 7 | 2 | 4 | 6 | 5 | 2 | 7 | 2 | 3 | 7 | 4 | 3 | 7 | 5 | 4 | 3 | 8 | 3 | 8 | 6 | 6 | 2 | 2 | 3 | 4 | 4 |
| hectori2.spc Hectorite SHCa- | 4 | 7 | 7 | 6 | 4 | 6 | 5 | 5 | 7 | 1 | 6 | 7 | 6 | 1 | 8 | 1 | 2 | 8 | 2 | 2 | 9 | 6 | 3 | 5 | 8 | 1 | 9 | 4 | 7 | 2 | 2 | 1 | 2 | 2 |
| hedenbe1.spc Hedenbergite | 6 | 1 | 1 | 1 | 8 | 0 | 5 | 0 | 3 | 7 | 7 | 1 | 7 | 3 | 5 | 3 | 2 | 3 | 6 | 4 | 1 | 1 | 2 | 3 | 6 | 7 | 6 | 7 | 5 | 8 | 8 | 8 | 8 | 9 |
| hedenbe2.spc Hedenbergite | 6 | 7 | 6 | 6 | 4 | 3 | 5 | 5 | 3 | 7 | 8 | 0 | 8 | 1 | 7 | 1 | 1 | 6 | 7 | 6 | 6 | 4 | 2 | 3 | 7 | 4 | 8 | 3 | 4 | 8 | 9 | 9 | 9 | 9 |
| hematit1.spc Hematite 2%+9 | 1 | 9 | 9 | 9 | 7 | 9 | 1 | 3 | 2 | 6 | 2 | 5 | 2 | 5 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 2 | 2 | 3 | 6 | 5 | 7 | 1 | 1 | 4 | 4 | 5 | 6 | 6 |
| hematit2.spc Hematite GDS2 | 5 | 9 | 9 | 9 | 8 | 9 | 0 | 1 | 0 | 9 | 3 | 4 | 3 | 4 | 3 | 3 | 3 | 5 | 4 | 4 | 4 | 3 | 3 | 5 | 4 | 4 | 4 | 0 | 0 | 6 | 6 | 6 | 7 | 6 |
| hematit3.spc Hematite GDS6 | 0 | 3 | 7 | 1 | 8 | 6 | 5 | 2 | 1 | 7 | 5 | 2 | 4 | 6 | 4 | 2 | 5 | 2 | 8 | 8 | 1 | 1 | 1 | 2 | 7 | 7 | 7 | 5 | 1 | 2 | 4 | 5 | 7 | 7 |
| hematit4.spc Hematite GDS6 | 0 | 4 | 5 | 0 | 7 | 6 | 2 | 1 | 1 | 7 | 4 | 2 | 2 | 2 | 7 | 1 | 1 | 2 | 6 | 3 | 2 | 1 | 1 | 3 | 5 | 6 | 5 | 4 | 0 | 4 | 6 | 6 | 7 | 8 |
| hematit5.spc Hematite GDS6 | 0 | 1 | 1 | 0 | 8 | 2 | 7 | 1 | 0 | 8 | 2 | 2 | 2 | 3 | 4 | 1 | 4 | 2 | 7 | 6 | 0 | 1 | 1 | 2 | 7 | 7 | 7 | 4 | 0 | 5 | 6 | 7 | 8 | 8 |
| hematit6.spc Hematite GDS6 | 0 | 1 | 0 | 0 | 6 | 2 | 2 | 1 | 0 | 8 | 6 | 3 | 5 | 2 | 5 | 1 | 2 | 2 | 7 | 7 | 3 | 1 | 1 | 2 | 7 | 6 | 7 | 3 | 0 | 6 | 6 | 7 | 8 | 8 |
| hematit7.spc Hematite GDS6 | 0 | 3 | 1 | 2 | 7 | 8 | 0 | 1 | 0 | 9 | 6 | 2 | 5 | 3 | 2 | 2 | 1 | 2 | 7 | 6 | 1 | 1 | 1 | 2 | 7 | 8 | 5 | 1 | 0 | 6 | 6 | 7 | 8 | 8 |
| hematit8.spc Hematite GDS6 | 0 | 6 | 7 | 6 | 8 | 9 | 0 | 1 | 0 | 9 | 6 | 2 | 5 | 3 | 4 | 2 | 1 | 2 | 7 | 6 | 1 | 1 | 1 | 2 | 6 | 7 | 6 | 1 | 0 | 6 | 6 | 7 | 8 | 8 |
| hematit9.spc Hematite GDS6 | 0 | 8 | 9 | 8 | 7 | 9 | 0 | 1 | 0 | 9 | 4 | 3 | 5 | 3 | 3 | 3 | 1 | 5 | 4 | 4 | 5 | 1 | 1 | 1 | 7 | 7 | 8 | 0 | 0 | 6 | 6 | 7 | 7 | 8 |
| hematita.spc Hematite HS45 | 0 | 8 | 9 | 8 | 2 | 9 | 0 | 7 | 8 | 2 | 1 | 7 | 1 | 4 | 0 | 4 | 3 | 2 | 7 | 7 | 5 | 1 | 1 | 2 | 7 | 6 | 7 | 1 | 1 | 1 | 2 | 3 | 4 | 5 |
| hematitb.spc Hematite WS16 | 2 | 9 | 9 | 9 | 7 | 9 | 0 | 1 | 1 | 7 | 5 | 2 | 6 | 3 | 5 | 2 | 2 | 2 | 7 | 6 | 2 | 1 | 2 | 3 | 6 | 7 | 6 | 0 | 0 | 6 | 7 | 7 | 8 | 8 |
| hematitc.spc Hematite FE26 | 0 | 8 | 9 | 8 | 8 | 9 | 0 | 1 | 0 | 8 | 4 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 6 | 4 | 1 | 1 | 2 | 3 | 6 | 7 | 6 | 0 | 0 | 4 | 5 | 6 | 7 | 7 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| heuland1.spc Heulandite GDS | 1 | 2 | 3 | 1 | 6 | 2 | 8 | 2 | 9 | 0 | 7 | 9 | 8 | 0 | 9 | 0 | 0 | 7 | 7 | 4 | 7 | 8 | 8 | 9 | 0 | 0 | 1 | 9 | 8 | 1 | 0 | 0 | 1 | 0 |
| heuland2.spc Heulandite NMI | 1 | 2 | 2 | 1 | 6 | 2 | 8 | 2 | 9 | 0 | 7 | 8 | 8 | 0 | 9 | 0 | 0 | 7 | 7 | 5 | 7 | 8 | 8 | 9 | 0 | 0 | 1 | 9 | 8 | 1 | 0 | 0 | 1 | 0 |
| hgrossul.spc Hydrogrossular | 1 | 6 | 7 | 4 | 5 | 6 | 5 | 3 | 7 | 1 | 1 | 7 | 2 | 8 | 5 | 7 | 9 | 3 | 1 | 2 | 1 | 6 | 7 | 8 | 0 | 1 | 1 | 6 | 7 | 1 | 1 | 1 | 1 | 1 |
| holmquis.spc Holmquistite H | 5 | 3 | 2 | 4 | 2 | 5 | 4 | 7 | 2 | 7 | 8 | 1 | 8 | 4 | 4 | 5 | 5 | 7 | 2 | 2 | 7 | 8 | 9 | 1 | 7 | 9 | 1 | 3 | 2 | 8 | 8 | 8 | 8 | 8 |
| horrible1.spc Hornblende_Mg | 7 | 6 | 6 | 6 | 0 | 7 | 6 | 9 | 0 | 9 | 7 | 2 | 7 | 8 | 1 | 8 | 6 | 8 | 3 | 2 | 7 | 6 | 4 | 1 | 8 | 3 | 9 | 1 | 0 | 8 | 8 | 8 | 8 | 8 |
| hornble2.spc Hornblende_Fe | 4 | 0 | 0 | 0 | 0 | 4 | 1 | 9 | 0 | 9 | 8 | 0 | 9 | 8 | 1 | 8 | 2 | 9 | 2 | 2 | 9 | 9 | 8 | 0 | 9 | 6 | 9 | 2 | 0 | 9 | 9 | 9 | 9 | 8 |
| hornble3.spc Hornblende HS | 2 | 1 | 1 | 1 | 2 | 3 | 1 | 6 | 2 | 9 | 9 | 0 | 9 | 2 | 6 | 3 | 1 | 8 | 7 | 5 | 7 | 8 | 9 | 1 | 8 | 8 | 7 | 5 | 1 | 9 | 9 | 9 | 9 | 9 |
| hornble4.spc Hornblende HS | 3 | 6 | 5 | 4 | 1 | 6 | 5 | 7 | 1 | 9 | 9 | 0 | 9 | 8 | 2 | 8 | 5 | 8 | 3 | 3 | 8 | 8 | 7 | 1 | 8 | 8 | 7 | 3 | 1 | 9 | 9 | 9 | 9 | 9 |
| howlite.spc Howlite GDS155 | 2 | 3 | 3 | 3 | 5 | 4 | 6 | 3 | 7 | 1 | 0 | 1 | 1 | 9 | 0 | 9 | 8 | 1 | 9 | 1 | 0 | 0 | 0 | 8 | 7 | 1 | 8 | 7 | 6 | 0 | 1 | 1 | 0 | 1 |
| hyperst1.spc Hypersthene N | 6 | 6 | 7 | 7 | 9 | 8 | 9 | 1 | 1 | 7 | 0 | 8 | 0 | 1 | 7 | 0 | 0 | 2 | 8 | 6 | 1 | 1 | 1 | 2 | 7 | 7 | 7 | 2 | 2 | 0 | 0 | 2 | 5 | 7 |
| hyperst2.spc Hypersthene P | 7 | 5 | 7 | 6 | 9 | 0 | 9 | 0 | 0 | 8 | 0 | 9 | 0 | 0 | 8 | 0 | 0 | 0 | 9 | 8 | 0 | 0 | 0 | 0 | 9 | 8 | 8 | 2 | 0 | 0 | 0 | 0 | 2 | 4 |
| hyperst3.spc Hypersthene P | 7 | 6 | 7 | 6 | 9 | 0 | 9 | 0 | 0 | 9 | 0 | 9 | 0 | 0 | 8 | 0 | 0 | 0 | 9 | 8 | 0 | 0 | 0 | 1 | 9 | 8 | 8 | 2 | 0 | 0 | 0 | 0 | 2 | 4 |
| hyperst4.spc Hypersthene P | 7 | 5 | 7 | 6 | 9 | 0 | 9 | 0 | 0 | 9 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 0 | 9 | 8 | 0 | 0 | 0 | 1 | 8 | 8 | 8 | 3 | 0 | 0 | 0 | 0 | 2 | 4 |
| hyperst5.spc Hypersthene P | 6 | 5 | 7 | 6 | 9 | 0 | 9 | 0 | 0 | 9 | 0 | 9 | 0 | 0 | 8 | 0 | 0 | 1 | 9 | 7 | 0 | 0 | 0 | 1 | 8 | 8 | 8 | 3 | 1 | 0 | 0 | 0 | 3 | 5 |
| hyperst6.spc Hypersthene P | 6 | 5 | 6 | 5 | 9 | 0 | 9 | 0 | 0 | 8 | 0 | 9 | 0 | 0 | 8 | 0 | 0 | 1 | 8 | 7 | 1 | 0 | 1 | 1 | 8 | 8 | 8 | 4 | 1 | 0 | 0 | 1 | 3 | 5 |
| hyperst7.spc Hypersthene P | 5 | 4 | 5 | 5 | 9 | 1 | 9 | 0 | 0 | 8 | 0 | 9 | 0 | 0 | 8 | 0 | 0 | 2 | 8 | 7 | 2 | 1 | 1 | 1 | 8 | 7 | 8 | 4 | 2 | 0 | 0 | 1 | 4 | 5 |
| hyperst8.spc Hypersthene P | 4 | 4 | 4 | 4 | 9 | 1 | 9 | 0 | 1 | 7 | 0 | 9 | 0 | 1 | 7 | 0 | 0 | 3 | 8 | 6 | 4 | 2 | 1 | 2 | 8 | 7 | 8 | 5 | 3 | 1 | 0 | 2 | 5 | 5 |
| hyperst9.spc Hypersthene P | 5 | 4 | 4 | 4 | 9 | 2 | 9 | 1 | 2 | 6 | 0 | 8 | 0 | 2 | 6 | 1 | 1 | 5 | 7 | 5 | 5 | 2 | 2 | 2 | 8 | 7 | 8 | 5 | 4 | 1 | 1 | 2 | 5 | 5 |
| illite1.spc Illite GDS4 (Marble | 3 | 4 | 5 | 4 | 1 | 6 | 1 | 7 | 3 | 6 | 7 | 1 | 7 | 1 | 8 | 5 | 7 | 1 | 0 | 0 | 0 | 9 | 9 | 8 | 1 | 6 | 0 | 3 | 2 | 7 | 7 | 7 | 7 | 4 |
| illite2.spc Illite IMt-1.a~~14 | 7 | 1 | 1 | 2 | 4 | 0 | 5 | 5 | 4 | 7 | 8 | 1 | 8 | 3 | 7 | 5 | 7 | 2 | 1 | 4 | 1 | 5 | 6 | 5 | 3 | 5 | 2 | 5 | 4 | 8 | 8 | 8 | 8 | 8 |
| illite3.spc Illite IMt-1.b <2um | 8 | 5 | 1 | 4 | 7 | 0 | 6 | 2 | 5 | 6 | 8 | 1 | 7 | 3 | 6 | 5 | 7 | 2 | 1 | 5 | 1 | 5 | 6 | 6 | 3 | 5 | 2 | 5 | 7 | 8 | 8 | 8 | 8 | 8 |
| illite4.spc Illite IL101 (2M2)~~ | 5 | 6 | 6 | 5 | 5 | 5 | 5 | 4 | 8 | 2 | 3 | 6 | 2 | 7 | 6 | 8 | 9 | 0 | 6 | 9 | 4 | 8 | 8 | 7 | 1 | 4 | 1 | 5 | 7 | 2 | 2 | 2 | 2 | 2 |
| illite5.spc Illite IL105 (1Md)~~ | 7 | 6 | 6 | 6 | 1 | 7 | 1 | 8 | 3 | 6 | 5 | 3 | 5 | 4 | 5 | 5 | 6 | 2 | 2 | 6 | 2 | 4 | 5 | 6 | 3 | 4 | 2 | 2 | 1 | 7 | 7 | 7 | 7 | 7 |
| ilmenite.spc Ilmenite HS231. | 0 | 4 | 4 | 1 | 1 | 6 | 2 | 6 | 8 | 2 | 1 | 9 | 1 | 4 | 0 | 1 | 7 | 6 | 8 | 1 | 3 | 0 | 2 | 2 | 7 | 8 | 7 | 8 | 5 | 3 | 4 | 5 | 6 | 7 |
| jadeite.spc Jadeite HS343.3E | 5 | 0 | 0 | 1 | 2 | 0 | 1 | 1 | 6 | 6 | 6 | 2 | 7 | 3 | 3 | 4 | 2 | 3 | 5 | 3 | 3 | 2 | 1 | 4 | 5 | 6 | 5 | 7 | 3 | 7 | 8 | 8 | 8 | 8 |
| jarosit1.spc Jarosite GDS99 | 9 | 9 | 8 | 9 | 9 | 7 | 9 | 0 | 1 | 7 | 8 | 7 | 8 | 8 | 3 | 8 | 8 | 1 | 0 | 3 | 4 | 0 | 0 | 7 | 7 | 1 | 8 | 0 | 8 | 7 | 6 | 6 | 2 | 4 |
| jarosit2.spc Jarosite GDS98 | 9 | 9 | 9 | 9 | 9 | 7 | 8 | 0 | 1 | 7 | 6 | 7 | 6 | 1 | 7 | 1 | 4 | 3 | 2 | 4 | 4 | 0 | 0 | 7 | 5 | 2 | 8 | 0 | 2 | 6 | 4 | 2 | 2 | 3 |
| jarosit3.spc Jarosite GDS100 | 9 | 9 | 8 | 9 | 9 | 5 | 8 | 0 | 1 | 7 | 5 | 5 | 5 | 2 | 5 | 2 | 7 | 4 | 4 | 3 | 2 | 0 | 0 | 6 | 6 | 2 | 8 | 0 | 3 | 6 | 4 | 3 | 3 | 4 |
| jarosit4.spc Jarosite GDS101 | 9 | 9 | 8 | 9 | 9 | 7 | 9 | 0 | 1 | 8 | 8 | 2 | 7 | 8 | 0 | 7 | 7 | 3 | 1 | 1 | 3 | 0 | 0 | 7 | 8 | 1 | 9 | 0 | 7 | 7 | 6 | 7 | 3 | 5 |
| jarosit5.spc Jarosite GDS24 | 9 | 9 | 9 | 9 | 9 | 8 | 9 | 0 | 0 | 9 | 9 | 2 | 8 | 9 | 0 | 8 | 8 | 1 | 0 | 0 | 0 | 0 | 0 | 8 | 7 | 0 | 8 | 0 | 5 | 8 | 7 | 8 | 3 | 5 |
| jarosit6.spc Jarosite JR2501 | 9 | 9 | 8 | 9 | 9 | 8 | 8 | 0 | 1 | 7 | 7 | 5 | 7 | 7 | 3 | 6 | 7 | 1 | 2 | 3 | 1 | 0 | 0 | 6 | 5 | 2 | 8 | 0 | 5 | 7 | 6 | 6 | 3 | 5 |
| jarosit7.spc Jarosite NMNH9 | 9 | 9 | 9 | 9 | 9 | 8 | 9 | 0 | 0 | 9 | 8 | 2 | 7 | 9 | 0 | 8 | 8 | 1 | 0 | 0 | 0 | 0 | 0 | 9 | 7 | 0 | 8 | 0 | 3 | 8 | 6 | 7 | 3 | 4 |
| jarosit8.spc Jarosite WS368 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 1 | 2 | 7 | 4 | 6 | 4 | 6 | 2 | 5 | 6 | 6 | 2 | 3 | 5 | 0 | 0 | 4 | 7 | 4 | 7 | 0 | 3 | 7 | 6 | 6 | 6 | 6 |
| jarosit9.spc Jarosite SJ-1 H3 | 9 | 9 | 9 | 9 | 9 | 7 | 9 | 0 | 0 | 8 | 6 | 7 | 7 | 2 | 6 | 1 | 6 | 3 | 1 | 2 | 2 | 0 | 0 | 8 | 3 | 1 | 6 | 0 | 2 | 7 | 5 | 2 | 1 | 2 |
| kainite.spc Kainite NMNH839 | 3 | 3 | 3 | 2 | 7 | 2 | 7 | 2 | 9 | 0 | 9 | 9 | 9 | 0 | 9 | 0 | 0 | 1 | 8 | 7 | 0 | 5 | 6 | 9 | 0 | 0 | 1 | 8 | 8 | 0 | 0 | 0 | 0 | 0 |
| kaolini1.spc Kaolinite CM9~~ | 3 | 3 | 3 | 3 | 4 | 3 | 6 | 6 | 7 | 3 | 4 | 7 | 4 | 9 | 0 | 9 | 9 | 0 | 9 | 9 | 7 | 7 | 6 | 6 | 3 | 2 | 7 | 6 | 6 | 4 | 2 | 2 | 1 | 1 |
| kaolini2.spc Kaolinite KGa-1 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 4 | 6 | 3 | 2 | 7 | 2 | 9 | 0 | 9 | 9 | 0 | 9 | 9 | 7 | 6 | 6 | 6 | 3 | 3 | 7 | 5 | 5 | 3 | 2 | 2 | 2 | 2 |
| kaolini3.spc Kaolinite KGa-2 | 7 | 7 | 6 | 6 | 3 | 4 | 3 | 4 | 5 | 3 | 3 | 7 | 2 | 9 | 2 | 9 | 9 | 0 | 9 | 9 | 7 | 6 | 6 | 6 | 3 | 2 | 7 | 3 | 4 | 2 | 2 | 3 | 2 | 2 |
| kaolini4.spc Kaolinite KL502 | 3 | 6 | 6 | 4 | 6 | 5 | 6 | 4 | 6 | 2 | 3 | 6 | 3 | 9 | 5 | 9 | 9 | 0 | 9 | 9 | 7 | 8 | 8 | 7 | 1 | 2 | 3 | 6 | 6 | 2 | 2 | 2 | 1 | 1 |
| kaolini5.spc Kaolinite GDS11 | 5 | 5 | 5 | 5 | 2 | 6 | 3 | 6 | 7 | 3 | 4 | 7 | 4 | 9 | 1 | 9 | 9 | 0 | 9 | 9 | 7 | 7 | 7 | 6 | 3 | 3 | 5 | 4 | 5 | 4 | 2 | 2 | 1 | 2 |
| kaolini6.spc Kaolinite CM3~~ | 5 | 5 | 5 | 5 | 3 | 5 | 5 | 6 | 7 | 2 | 4 | 7 | 2 | 9 | 1 | 9 | 9 | 0 | 9 | 9 | 7 | 7 | 6 | 6 | 3 | 2 | 7 | 4 | 5 | 2 | 2 | 2 | 1 | 2 |
| kaolini7.spc Kaolinite CM5~~ | 5 | 5 | 5 | 5 | 3 | 6 | 4 | 5 | 7 | 2 | 2 | 7 | 2 | 9 | 2 | 9 | 9 | 0 | 9 | 9 | 7 | 7 | 6 | 6 | 3 | 2 | 5 | 4 | 5 | 2 | 2 | 2 | 1 | 2 |
| kaolini8.spc Kaolinite CM7~~ | 8 | 7 | 6 | 7 | 4 | 5 | 6 | 4 | 6 | 2 | 1 | 7 | 1 | 9 | 1 | 9 | 9 | 0 | 9 | 9 | 7 | 7 | 7 | 7 | 2 | 2 | 4 | 3 | 6 | 2 | 2 | 2 | 1 | 1 |
| kaosmec1.spc Kaolin/Smect | 6 | 7 | 7 | 7 | 2 | 8 | 1 | 6 | 3 | 5 | 4 | 5 | 4 | 7 | 5 | 7 | 8 | 1 | 8 | 9 | 5 | 6 | 5 | 6 | 3 | 3 | 4 | 2 | 2 | 5 | 5 | 4 | 4 | 3 |
| kaosmec2.spc Kaolin/Smect | 5 | 7 | 8 | 7 | 0 | 9 | 0 | 8 | 2 | 6 | 7 | 4 | 6 | 4 | 8 | 7 | 9 | 1 | 9 | 9 | 6 | 7 | 7 | 8 | 2 | 2 | 3 | 1 | 0 | 7 | 6 | 5 | 4 | 3 |
| kaosmec3.spc Kaolin/Smect | 7 | 7 | 7 | 7 | 2 | 7 | 3 | 7 | 5 | 5 | 5 | 5 | 5 | 4 | 7 | 6 | 8 | 1 | 8 | 9 | 5 | 6 | 6 | 7 | 2 | 2 | 4 | 2 | 4 | 6 | 5 | 4 | 4 | 3 |
| kaosmec4.spc Kaolin/Smect | 7 | 8 | 8 | 7 | 1 | 8 | 1 | 7 | 3 | 5 | 5 | 6 | 6 | 2 | 8 | 4 | 9 | 1 | 8 | 9 | 5 | 6 | 7 | 8 | 2 | 2 | 2 | 1 | 2 | 5 | 4 | 3 | 3 | 2 |
| kaosmec5.spc Kaolin/Smect | 9 | 8 | 7 | 8 | 3 | 7 | 5 | 7 | 3 | 4 | 5 | 5 | 6 | 1 | 8 | 2 | 8 | 2 | 5 | 8 | 4 | 6 | 6 | 7 | 2 | 2 | 2 | 1 | 4 | 5 | 4 | 3 | 3 | 3 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| kerogenb.spc Kerogen BK-C | 3 | 8 | 8 | 8 | 0 | 9 | 0 | 9 | 5 | 4 | 4 | 4 | 4 | 6 | 5 | 5 | 5 | 2 | 7 | 4 | 5 | 0 | 0 | 2 | 3 | 7 | 4 | 1 | 1 | 4 | 5 | 6 | 5 | 7 |
| labrado1.spc Labradorite HS | 3 | 2 | 2 | 2 | 5 | 3 | 6 | 4 | 8 | 4 | 4 | 2 | 4 | 5 | 3 | 4 | 5 | 5 | 6 | 5 | 4 | 3 | 4 | 4 | 4 | 7 | 3 | 7 | 7 | 6 | 6 | 6 | 7 | 7 |
| labrado2.spc Labradorite HS | 0 | 4 | 6 | 4 | 0 | 8 | 2 | 8 | 9 | 1 | 1 | 2 | 3 | 3 | 5 | 2 | 2 | 2 | 6 | 5 | 1 | 1 | 2 | 3 | 5 | 7 | 4 | 6 | 8 | 1 | 3 | 4 | 6 | 6 |
| laumonti.spc Laumontite GD | 2 | 3 | 3 | 2 | 5 | 3 | 7 | 3 | 9 | 1 | 8 | 9 | 8 | 0 | 9 | 0 | 3 | 7 | 4 | 3 | 6 | 7 | 7 | 9 | 0 | 0 | 1 | 8 | 8 | 1 | 1 | 1 | 1 | 1 |
| lazurite.spc Lazurite HS418. | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 4 | 3 | 2 | 6 | 4 | 1 | 8 | 1 | 1 | 4 | 7 | 6 | 4 | 4 | 5 | 8 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 4 | 3 |
| lepidocr.spc Lepidocrosite G | 9 | 9 | 9 | 9 | 9 | 8 | 9 | 7 | 0 | 9 | 0 | 9 | 0 | 5 | 4 | 5 | 6 | 7 | 4 | 3 | 6 | 6 | 5 | 7 | 3 | 2 | 3 | 0 | 0 | 7 | 6 | 6 | 5 | 4 |
| lepidol1.spc Lepidolite HS16 | 0 | 4 | 7 | 2 | 3 | 4 | 1 | 3 | 3 | 5 | 4 | 5 | 4 | 8 | 1 | 8 | 9 | 0 | 9 | 9 | 5 | 8 | 9 | 7 | 1 | 6 | 0 | 7 | 2 | 5 | 4 | 4 | 4 | 3 |
| lepidol2.spc Lepidolite NMNH | 0 | 7 | 9 | 5 | 6 | 7 | 0 | 1 | 1 | 7 | 5 | 4 | 6 | 9 | 3 | 9 | 9 | 0 | 8 | 9 | 5 | 9 | 9 | 9 | 0 | 3 | 0 | 4 | 0 | 7 | 7 | 6 | 2 | 0 |
| lepidol3.spc Lepidolite NMNH | 0 | 7 | 8 | 5 | 7 | 8 | 0 | 1 | 1 | 8 | 7 | 5 | 7 | 8 | 6 | 9 | 9 | 0 | 0 | 9 | 0 | 9 | 9 | 9 | 0 | 2 | 0 | 3 | 0 | 7 | 7 | 6 | 3 | 1 |
| lepidol4.spc Lepidolite NMNH | 0 | 5 | 8 | 5 | 6 | 7 | 1 | 1 | 1 | 7 | 5 | 3 | 5 | 9 | 1 | 9 | 9 | 0 | 2 | 9 | 2 | 9 | 9 | 8 | 0 | 3 | 0 | 4 | 1 | 7 | 7 | 6 | 3 | 2 |
| lepidol5.spc Lepidolite NMNH | 0 | 6 | 8 | 6 | 8 | 8 | 1 | 0 | 1 | 8 | 5 | 3 | 6 | 9 | 1 | 9 | 9 | 0 | 0 | 9 | 0 | 9 | 9 | 9 | 0 | 3 | 0 | 3 | 0 | 7 | 7 | 7 | 3 | 1 |
| limonite.spc Limonite HS41. | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 5 | 0 | 9 | 0 | 7 | 0 | 2 | 6 | 2 | 6 | 8 | 1 | 1 | 7 | 8 | 8 | 8 | 1 | 2 | 1 | 0 | 0 | 8 | 8 | 7 | 7 | 4 |
| lizardi1.spc Lizardite NMNHR | 6 | 7 | 7 | 7 | 4 | 6 | 7 | 7 | 7 | 5 | 6 | 7 | 6 | 6 | 7 | 9 | 0 | 9 | 1 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 1 | 3 | 7 | 6 | 6 | 3 | 4 | 1 |
| lizardi2.spc Lizardite NMNHR | 7 | 7 | 7 | 8 | 2 | 7 | 6 | 7 | 6 | 5 | 5 | 5 | 6 | 6 | 7 | 9 | 0 | 9 | 2 | 1 | 9 | 9 | 9 | 0 | 9 | 9 | 1 | 3 | 7 | 6 | 6 | 3 | 1 | 1 |
| lizardi3.spc Lizardite NMNHR | 7 | 7 | 7 | 8 | 3 | 6 | 5 | 6 | 8 | 5 | 6 | 7 | 4 | 4 | 7 | 8 | 0 | 9 | 2 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 7 | 2 | 6 | 6 | 6 | 3 | 2 | 2 |
| lizardi4.spc Lizardite NMNHR | 7 | 7 | 7 | 7 | 3 | 6 | 2 | 5 | 6 | 3 | 4 | 6 | 2 | 4 | 7 | 8 | 5 | 8 | 1 | 0 | 9 | 2 | 0 | 1 | 9 | 2 | 9 | 3 | 5 | 4 | 3 | 3 | 2 | 2 |
| maghemit.spc Maghemite G | 9 | 9 | 9 | 9 | 1 | 9 | 8 | 9 | 3 | 4 | 3 | 2 | 4 | 2 | 6 | 1 | 1 | 2 | 7 | 5 | 1 | 2 | 2 | 4 | 5 | 5 | 6 | 0 | 5 | 2 | 5 | 6 | 7 | 8 |
| magnesit.spc Magnesite+Hy | 3 | 4 | 3 | 3 | 3 | 2 | 2 | 3 | 8 | 1 | 4 | 5 | 3 | 2 | 4 | 1 | 1 | 7 | 3 | 2 | 7 | 1 | 0 | 5 | 8 | 2 | 8 | 6 | 5 | 1 | 2 | 1 | 2 | 3 |
| magneti1.spc Magnetite HS1 | 0 | 2 | 2 | 0 | 8 | 1 | 8 | 1 | 4 | 6 | 7 | 0 | 7 | 4 | 1 | 1 | 5 | 2 | 6 | 3 | 5 | 0 | 1 | 5 | 4 | 4 | 5 | 9 | 8 | 8 | 8 | 8 | 8 | 8 |
| magneti2.spc Magnetite HS7 | 0 | 2 | 4 | 1 | 7 | 4 | 7 | 3 | 8 | 4 | 2 | 6 | 4 | 6 | 6 | 1 | 5 | 2 | 9 | 8 | 6 | 2 | 1 | 5 | 3 | 7 | 3 | 9 | 8 | 5 | 6 | 7 | 7 | 8 |
| malachit.spc Malachite HS2 | 8 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 8 | 6 | 9 | 0 | 9 | 3 | 1 | 2 | 7 | 6 | 0 | 0 | 1 | 0 | 0 | 8 | 0 | 1 | 1 | 6 | 1 | 8 | 9 | 9 | 8 | 8 |
| manganit.spc Manganite HS | 2 | 2 | 1 | 0 | 1 | 2 | 0 | 6 | 1 | 7 | 1 | 7 | 1 | 7 | 1 | 6 | 6 | 4 | 5 | 7 | 5 | 4 | 2 | 4 | 3 | 6 | 3 | 4 | 0 | 6 | 6 | 5 | 5 | 6 |
| margarit.spc Margarite GDS1 | 6 | 3 | 2 | 5 | 6 | 2 | 6 | 6 | 3 | 6 | 7 | 2 | 6 | 7 | 6 | 6 | 9 | 1 | 4 | 9 | 8 | 8 | 9 | 6 | 2 | 8 | 0 | 4 | 4 | 7 | 7 | 7 | 4 | 3 |
| marialit.spc Marialite NMNH1 | 1 | 1 | 3 | 1 | 4 | 5 | 4 | 5 | 6 | 2 | 4 | 6 | 4 | 2 | 6 | 3 | 5 | 6 | 2 | 3 | 5 | 5 | 5 | 4 | 6 | 4 | 7 | 7 | 6 | 3 | 3 | 3 | 4 | 4 |
| mascagn1.spc Mascagnite G | 0 | 1 | 2 | 0 | 7 | 2 | 6 | 2 | 8 | 0 | 9 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 2 | 9 | 0 | 0 | 0 | 0 | 9 | 9 | 9 | 9 | 9 | 0 | 0 | 0 | 0 | 0 |
| meionit1.spc Meionite WS70 | 4 | 2 | 3 | 4 | 4 | 4 | 6 | 5 | 9 | 1 | 5 | 4 | 5 | 3 | 6 | 3 | 5 | 5 | 3 | 5 | 4 | 5 | 4 | 6 | 4 | 3 | 4 | 7 | 8 | 2 | 3 | 5 | 6 | 5 |
| meionit2.spc Meionite WS70 | 3 | 3 | 3 | 3 | 5 | 3 | 4 | 3 | 4 | 5 | 2 | 4 | 3 | 6 | 3 | 6 | 5 | 6 | 3 | 3 | 2 | 5 | 4 | 5 | 4 | 6 | 2 | 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| mesolite.spc Mesolite+Hydro | 1 | 2 | 3 | 2 | 6 | 3 | 6 | 2 | 9 | 0 | 1 | 9 | 3 | 1 | 9 | 0 | 7 | 3 | 9 | 8 | 4 | 6 | 6 | 9 | 0 | 0 | 2 | 8 | 8 | 0 | 0 | 0 | 1 | 0 |
| microcl1.spc Microcline HS8 | 4 | 8 | 8 | 7 | 3 | 6 | 3 | 5 | 7 | 2 | 3 | 3 | 3 | 5 | 4 | 3 | 5 | 3 | 6 | 6 | 3 | 2 | 3 | 4 | 5 | 6 | 5 | 3 | 6 | 3 | 4 | 5 | 5 | 6 |
| microcl2.spc Microcline HS1 | 4 | 4 | 4 | 4 | 7 | 3 | 7 | 2 | 9 | 2 | 6 | 2 | 6 | 4 | 4 | 3 | 6 | 2 | 5 | 7 | 2 | 3 | 2 | 4 | 5 | 5 | 6 | 7 | 8 | 6 | 6 | 6 | 7 | 7 |
| microcl3.spc Microcline HS1 | 3 | 4 | 5 | 4 | 3 | 5 | 4 | 5 | 5 | 4 | 2 | 5 | 3 | 7 | 3 | 8 | 8 | 1 | 8 | 9 | 5 | 6 | 7 | 6 | 2 | 4 | 1 | 5 | 5 | 3 | 3 | 4 | 4 | 3 |
| microcl4.spc Microcline HS1 | 4 | 8 | 8 | 7 | 5 | 5 | 4 | 4 | 6 | 3 | 3 | 5 | 3 | 3 | 5 | 3 | 3 | 3 | 4 | 6 | 2 | 3 | 3 | 4 | 5 | 5 | 4 | 4 | 6 | 4 | 4 | 5 | 6 | 6 |
| microcl5.spc Microcline HS1 | 3 | 7 | 7 | 5 | 3 | 5 | 3 | 5 | 6 | 3 | 3 | 4 | 4 | 3 | 5 | 3 | 3 | 4 | 5 | 5 | 2 | 3 | 3 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 6 | 6 |
| microcl6.spc Microcline NMN | 4 | 0 | 0 | 3 | 1 | 6 | 1 | 7 | 6 | 4 | 2 | 4 | 3 | 5 | 4 | 4 | 4 | 3 | 5 | 5 | 2 | 2 | 2 | 3 | 6 | 6 | 6 | 5 | 3 | 4 | 4 | 5 | 6 | 6 |
| mirabili.spc Mirabilite GDS15 | 0 | 1 | 2 | 0 | 7 | 1 | 7 | 2 | 9 | 0 | 9 | 9 | 9 | 0 | 9 | 0 | 1 | 1 | 7 | 6 | 0 | 4 | 6 | 8 | 1 | 1 | 2 | 9 | 9 | 0 | 0 | 0 | 1 | 1 |
| mizzoni1.spc Mizzonite NMN | 0 | 0 | 1 | 1 | 1 | 8 | 2 | 8 | 5 | 5 | 4 | 4 | 4 | 3 | 6 | 4 | 6 | 4 | 5 | 6 | 3 | 4 | 4 | 6 | 3 | 3 | 4 | 6 | 4 | 6 | 6 | 5 | 6 | 5 |
| mizzoni2.spc Mizzonite BM1 | 5 | 3 | 4 | 5 | 3 | 5 | 3 | 5 | 5 | 3 | 3 | 5 | 3 | 7 | 5 | 7 | 8 | 2 | 1 | 6 | 0 | 9 | 9 | 7 | 0 | 8 | 0 | 4 | 5 | 3 | 3 | 3 | 3 | 3 |
| mizzoni3.spc Mizzonite HS3 | 0 | 0 | 2 | 3 | 0 | 9 | 1 | 9 | 5 | 5 | 5 | 4 | 5 | 4 | 7 | 6 | 6 | 4 | 4 | 7 | 3 | 5 | 5 | 7 | 3 | 3 | 3 | 4 | 3 | 6 | 5 | 5 | 5 | 4 |
| mizzoni4.spc Mizzonite HS3 | 6 | 1 | 1 | 5 | 5 | 1 | 5 | 4 | 4 | 5 | 5 | 7 | 6 | 6 | 7 | 7 | 8 | 8 | 0 | 0 | 5 | 9 | 9 | 7 | 0 | 9 | 0 | 4 | 4 | 6 | 5 | 5 | 2 | 2 |
| monazite.spc Monazite HS2 | 9 | 9 | 9 | 9 | 8 | 8 | 0 | 0 | 2 | 0 | 9 | 0 | 9 | 1 | 8 | 0 | 5 | 7 | 2 | 2 | 7 | 7 | 7 | 9 | 0 | 1 | 1 | 0 | 1 | 0 | 4 | 2 | 3 | 2 |
| monticel.spc Monticellite HS | 2 | 1 | 1 | 1 | 8 | 3 | 8 | 4 | 4 | 5 | 1 | 8 | 0 | 4 | 2 | 2 | 2 | 4 | 6 | 3 | 3 | 1 | 1 | 3 | 5 | 7 | 6 | 8 | 7 | 4 | 2 | 3 | 5 | 6 |
| montmor1.spc Montmorillonit | 6 | 5 | 3 | 5 | 5 | 5 | 5 | 4 | 5 | 3 | 5 | 6 | 5 | 2 | 7 | 3 | 8 | 1 | 1 | 8 | 1 | 6 | 7 | 8 | 2 | 2 | 2 | 4 | 5 | 4 | 3 | 3 | 4 | 3 |
| montmor2.spc Montmorillonit | 3 | 6 | 6 | 5 | 3 | 6 | 4 | 6 | 7 | 1 | 7 | 8 | 8 | 0 | 9 | 1 | 2 | 4 | 0 | 2 | 2 | 7 | 7 | 9 | 1 | 1 | 2 | 5 | 6 | 1 | 1 | 1 | 2 | 1 |
| montmor3.spc Montmorillonit | 5 | 7 | 8 | 7 | 3 | 7 | 3 | 6 | 7 | 1 | 7 | 8 | 8 | 0 | 9 | 0 | 2 | 4 | 0 | 1 | 1 | 8 | 8 | 9 | 0 | 0 | 1 | 3 | 4 | 1 | 1 | 1 | 1 | 1 |
| montmor4.spc Montmorillonit | 5 | 8 | 8 | 7 | 2 | 7 | 2 | 6 | 4 | 2 | 7 | 7 | 7 | 0 | 9 | 1 | 3 | 4 | 0 | 0 | 1 | 7 | 8 | 9 | 0 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 1 |
| montmor5.spc Montmorillonit | 6 | 5 | 4 | 5 | 7 | 3 | 7 | 3 | 6 | 2 | 5 | 8 | 6 | 2 | 8 | 6 | 8 | 1 | 2 | 8 | 2 | 7 | 7 | 8 | 1 | 1 | 2 | 5 | 7 | 3 | 2 | 2 | 2 | 2 |
| montmor6.spc Montmorillonit | 8 | 8 | 7 | 8 | 6 | 8 | 7 | 6 | 3 | 1 | 7 | 8 | 7 | 0 | 9 | 2 | 7 | 1 | 0 | 8 | 1 | 7 | 7 | 9 | 1 | 1 | 1 | 1 | 5 | 1 | 1 | 1 | 1 | 1 |
| montmor7.spc Montmorillonit | 7 | 6 | 5 | 6 | 6 | 5 | 6 | 4 | 4 | 3 | 4 | 8 | 5 | 2 | 8 | 6 | 8 | 1 | 1 | 8 | 1 | 6 | 7 | 8 | 1 | 2 | 2 | 3 | 7 | 3 | 2 | 2 | 2 | 2 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| montmor8.spc Montmorillonit | 3 | 4 | 4 | 3 | 5 | 3 | 5 | 3 | 7 | 1 | 6 | 8 | 6 | 1 | 8 | 2 | 6 | 1 | 1 | 8 | 4 | 6 | 6 | 8 | 1 | 1 | 2 | 6 | 6 | 2 | 2 | 1 | 2 | 2 |
| montmor9.spc Montmorillonit | 9 | 8 | 8 | 8 | 2 | 7 | 3 | 7 | 3 | 6 | 5 | 5 | 4 | 6 | 5 | 7 | 6 | 1 | 0 | 6 | 0 | 6 | 7 | 6 | 2 | 4 | 1 | 1 | 2 | 5 | 5 | 3 | 4 | 3 |
| montmora.spc Montmorillonit | 9 | 8 | 8 | 8 | 6 | 6 | 7 | 6 | 3 | 5 | 6 | 7 | 6 | 1 | 8 | 3 | 7 | 2 | 0 | 2 | 0 | 7 | 8 | 8 | 2 | 2 | 1 | 1 | 4 | 5 | 3 | 2 | 3 | 2 |
| mordeni1.spc Mordenite GDS | 6 | 6 | 6 | 6 | 4 | 6 | 5 | 5 | 5 | 2 | 6 | 8 | 6 | 1 | 8 | 2 | 1 | 6 | 4 | 4 | 6 | 6 | 5 | 9 | 1 | 1 | 2 | 4 | 6 | 2 | 2 | 2 | 3 | 2 |
| mordeni2.spc Mordenite+Clin | 7 | 7 | 6 | 7 | 4 | 6 | 5 | 5 | 7 | 1 | 6 | 8 | 6 | 1 | 8 | 1 | 2 | 6 | 4 | 3 | 6 | 5 | 5 | 8 | 2 | 1 | 3 | 3 | 6 | 2 | 2 | 2 | 3 | 2 |
| muscovi1.spc Muscovite GDS | 8 | 6 | 7 | 8 | 4 | 7 | 5 | 6 | 3 | 6 | 4 | 4 | 4 | 8 | 3 | 9 | 8 | 0 | 1 | 9 | 0 | 9 | 9 | 8 | 1 | 4 | 0 | 1 | 3 | 6 | 6 | 6 | 3 | 2 |
| muscovi2.spc Muscovite GDS | 7 | 5 | 5 | 7 | 5 | 6 | 5 | 5 | 5 | 4 | 3 | 5 | 2 | 7 | 4 | 8 | 8 | 0 | 3 | 9 | 1 | 7 | 8 | 7 | 2 | 4 | 1 | 3 | 5 | 4 | 4 | 4 | 4 | 3 |
| muscovi3.spc Muscovite GDS | 5 | 2 | 3 | 4 | 2 | 1 | 1 | 6 | 3 | 7 | 6 | 2 | 6 | 6 | 6 | 7 | 7 | 1 | 0 | 0 | 0 | 5 | 7 | 7 | 0 | 5 | 0 | 4 | 2 | 7 | 7 | 7 | 6 | 5 |
| muscovi4.spc Muscovite GDS | 4 | 5 | 6 | 5 | 7 | 7 | 6 | 3 | 4 | 5 | 4 | 5 | 3 | 8 | 2 | 8 | 8 | 0 | 4 | 9 | 3 | 8 | 9 | 7 | 1 | 5 | 0 | 4 | 5 | 6 | 5 | 4 | 4 | 3 |
| muscovi5.spc Muscovite GDS | 3 | 2 | 2 | 3 | 5 | 4 | 3 | 5 | 4 | 5 | 4 | 5 | 3 | 7 | 5 | 7 | 8 | 0 | 0 | 8 | 0 | 6 | 7 | 7 | 1 | 3 | 0 | 5 | 4 | 5 | 5 | 5 | 4 | 3 |
| muscovi6.spc Muscovite GDS | 4 | 4 | 5 | 5 | 2 | 7 | 2 | 7 | 3 | 6 | 5 | 3 | 5 | 8 | 3 | 8 | 8 | 0 | 0 | 7 | 0 | 7 | 8 | 7 | 0 | 4 | 0 | 4 | 2 | 7 | 7 | 7 | 5 | 4 |
| muscovi7.spc Muscovite GDS | 3 | 3 | 3 | 3 | 7 | 2 | 5 | 2 | 4 | 5 | 4 | 5 | 4 | 7 | 6 | 8 | 8 | 0 | 1 | 9 | 0 | 8 | 9 | 7 | 1 | 4 | 0 | 6 | 4 | 6 | 6 | 5 | 4 | 3 |
| muscovi8.spc Muscovite GDS | 4 | 3 | 3 | 3 | 5 | 5 | 4 | 6 | 6 | 6 | 4 | 5 | 4 | 6 | 5 | 7 | 7 | 1 | 0 | 8 | 0 | 6 | 7 | 7 | 1 | 3 | 1 | 5 | 4 | 6 | 6 | 6 | 5 | 4 |
| muscovi9.spc Muscovite GDS | 3 | 3 | 4 | 4 | 5 | 6 | 5 | 5 | 4 | 4 | 3 | 6 | 3 | 6 | 5 | 7 | 8 | 0 | 1 | 9 | 0 | 7 | 8 | 7 | 1 | 3 | 1 | 5 | 4 | 5 | 3 | 3 | 3 | 3 |
| muscovia.spc Muscovite GDS | 3 | 3 | 4 | 3 | 5 | 6 | 5 | 5 | 4 | 5 | 3 | 6 | 3 | 6 | 5 | 7 | 8 | 0 | 1 | 9 | 0 | 7 | 8 | 7 | 1 | 3 | 1 | 5 | 4 | 5 | 4 | 4 | 3 | 3 |
| muscovib.spc Muscovite HS1 | 3 | 3 | 3 | 4 | 5 | 6 | 4 | 6 | 7 | 6 | 7 | 2 | 6 | 8 | 3 | 9 | 8 | 0 | 0 | 9 | 0 | 8 | 9 | 8 | 0 | 4 | 0 | 5 | 4 | 7 | 7 | 7 | 6 | 3 |
| muscovic.spc Muscovite HS2 | 5 | 5 | 6 | 6 | 2 | 7 | 2 | 7 | 3 | 6 | 5 | 4 | 5 | 8 | 3 | 8 | 8 | 0 | 0 | 8 | 0 | 8 | 9 | 8 | 0 | 4 | 0 | 3 | 3 | 7 | 7 | 7 | 4 | 3 |
| muscovid.spc Muscovite IL10 | 5 | 5 | 5 | 5 | 2 | 6 | 2 | 6 | 4 | 5 | 3 | 4 | 3 | 6 | 4 | 6 | 7 | 1 | 0 | 7 | 0 | 5 | 6 | 6 | 2 | 3 | 1 | 3 | 3 | 6 | 6 | 6 | 5 | 4 |
| nacrite.spc Nacrite GDS88~ | 2 | 1 | 2 | 2 | 4 | 5 | 5 | 5 | 8 | 2 | 2 | 7 | 1 | 9 | 1 | 9 | 9 | 0 | 9 | 9 | 7 | 7 | 7 | 7 | 2 | 2 | 5 | 7 | 6 | 2 | 2 | 3 | 2 | 2 |
| natroli1.spc Natrolite HS169. | 2 | 3 | 4 | 3 | 3 | 4 | 5 | 5 | 8 | 0 | 7 | 1 | 7 | 0 | 9 | 0 | 2 | 0 | 9 | 9 | 1 | 6 | 7 | 9 | 0 | 0 | 0 | 7 | 7 | 0 | 1 | 0 | 1 | 0 |
| natroli2.spc Natrolite+Zeolit H | 2 | 4 | 4 | 4 | 3 | 5 | 6 | 5 | 8 | 1 | 3 | 8 | 5 | 0 | 9 | 0 | 0 | 4 | 8 | 8 | 5 | 7 | 7 | 9 | 0 | 0 | 1 | 7 | 7 | 0 | 1 | 0 | 1 | 0 |
| natroli3.spc Natrolite NMNH8 | 2 | 5 | 5 | 3 | 5 | 4 | 5 | 3 | 9 | 1 | 1 | 3 | 5 | 0 | 8 | 0 | 5 | 1 | 8 | 8 | 3 | 6 | 5 | 9 | 0 | 0 | 2 | 7 | 7 | 0 | 1 | 0 | 2 | 1 |
| neodymiu.spc Neodymium_C | 0 | 7 | 0 | 2 | 8 | 0 | 0 | 0 | 7 | 2 | 0 | 0 | 0 | 7 | 1 | 7 | 7 | 9 | 2 | 3 | 9 | 9 | 9 | 3 | 8 | 8 | 3 | 8 | 0 | 1 | 2 | 2 | 2 | 1 |
| nephelin.spc Nepheline HS19 | 1 | 2 | 3 | 1 | 5 | 3 | 5 | 4 | 7 | 2 | 2 | 6 | 3 | 3 | 5 | 4 | 4 | 4 | 6 | 5 | 4 | 3 | 4 | 6 | 4 | 3 | 5 | 8 | 7 | 3 | 3 | 4 | 5 | 5 |
| nephrite.spc Nephrite HS296. | 3 | 0 | 0 | 0 | 7 | 1 | 7 | 7 | 4 | 6 | 4 | 5 | 5 | 5 | 6 | 8 | 1 | 9 | 3 | 1 | 9 | 9 | 8 | 0 | 9 | 9 | 9 | 8 | 6 | 7 | 7 | 6 | 4 | 3 |
| niter.spc Niter GDS43 (K-Sal | 0 | 1 | 2 | 0 | 6 | 2 | 5 | 2 | 6 | 3 | 3 | 6 | 2 | 3 | 6 | 7 | 0 | 6 | 2 | 2 | 1 | 1 | 5 | 9 | 1 | 0 | 4 | 8 | 6 | 3 | 3 | 4 | 4 | 2 |
| nontron1.spc Nontronite GDS | 9 | 7 | 6 | 8 | 0 | 7 | 1 | 9 | 2 | 8 | 8 | 1 | 8 | 2 | 7 | 2 | 5 | 7 | 1 | 2 | 7 | 5 | 5 | 4 | 2 | 8 | 2 | 1 | 1 | 8 | 8 | 8 | 8 | 8 |
| nontron2.spc Nontronite NG-1 | 9 | 9 | 8 | 9 | 6 | 9 | 8 | 8 | 1 | 6 | 6 | 5 | 7 | 0 | 9 | 1 | 2 | 7 | 2 | 1 | 7 | 3 | 0 | 8 | 2 | 0 | 6 | 0 | 2 | 4 | 3 | 2 | 3 | 2 |
| nontron3.spc Nontronite NG-1 | 9 | 9 | 9 | 9 | 8 | 9 | 9 | 7 | 1 | 6 | 6 | 3 | 7 | 0 | 9 | 1 | 4 | 7 | 1 | 0 | 7 | 2 | 0 | 9 | 2 | 0 | 8 | 0 | 5 | 5 | 5 | 3 | 3 | 2 |
| nontron4.spc Nontronite SWa | 9 | 9 | 7 | 9 | 0 | 9 | 5 | 9 | 1 | 6 | 7 | 7 | 8 | 0 | 9 | 0 | 2 | 7 | 1 | 0 | 6 | 5 | 0 | 9 | 1 | 0 | 5 | 0 | 1 | 4 | 2 | 1 | 2 | 1 |
| nontron5.spc Nontronite SWa | 9 | 9 | 8 | 9 | 1 | 9 | 7 | 9 | 0 | 6 | 7 | 8 | 8 | 0 | 9 | 0 | 6 | 7 | 0 | 0 | 7 | 5 | 0 | 9 | 0 | 0 | 5 | 0 | 1 | 5 | 2 | 1 | 1 | 1 |
| oligocl1.spc Oligoclase HS11 | 1 | 3 | 4 | 2 | 6 | 4 | 6 | 3 | 8 | 2 | 4 | 5 | 4 | 2 | 6 | 3 | 4 | 4 | 4 | 7 | 3 | 4 | 4 | 5 | 3 | 5 | 3 | 8 | 8 | 5 | 5 | 4 | 5 | 5 |
| oligocl2.spc Oligoclase HS14 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 8 | 2 | 3 | 4 | 3 | 5 | 3 | 4 | 5 | 3 | 5 | 7 | 3 | 3 | 4 | 4 | 4 | 6 | 4 | 6 | 7 | 5 | 5 | 5 | 6 | 6 |
| olivine1.spc Olivine NMNH13 | 8 | 5 | 0 | 5 | 9 | 0 | 9 | 0 | 0 | 9 | 9 | 1 | 9 | 3 | 5 | 2 | 1 | 2 | 7 | 6 | 2 | 1 | 2 | 3 | 6 | 6 | 6 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivine2.spc Olivine NMNH13 | 4 | 4 | 1 | 3 | 9 | 0 | 9 | 0 | 2 | 7 | 7 | 2 | 8 | 4 | 3 | 3 | 3 | 4 | 6 | 4 | 2 | 2 | 3 | 3 | 6 | 6 | 6 | 9 | 9 | 8 | 8 | 8 | 8 | 9 |
| olivine3.spc Olivine GDS70.a | 8 | 6 | 0 | 6 | 9 | 0 | 9 | 0 | 0 | 9 | 9 | 0 | 9 | 5 | 2 | 4 | 3 | 3 | 6 | 5 | 3 | 2 | 2 | 3 | 6 | 6 | 6 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivine4.spc Olivine GDS70.b | 8 | 6 | 1 | 6 | 9 | 0 | 9 | 0 | 1 | 9 | 9 | 1 | 9 | 5 | 4 | 4 | 3 | 4 | 5 | 4 | 2 | 1 | 2 | 3 | 6 | 6 | 7 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivine5.spc Olivine GDS70.c | 7 | 6 | 1 | 6 | 9 | 0 | 9 | 0 | 0 | 9 | 9 | 1 | 9 | 5 | 3 | 5 | 3 | 4 | 6 | 4 | 4 | 2 | 1 | 2 | 7 | 6 | 7 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivine6.spc Olivine GDS70.d | 6 | 5 | 3 | 5 | 9 | 1 | 9 | 1 | 2 | 7 | 7 | 3 | 7 | 5 | 3 | 5 | 4 | 5 | 5 | 3 | 4 | 1 | 1 | 2 | 7 | 6 | 7 | 8 | 9 | 8 | 8 | 8 | 8 | 8 |
| olivine7.spc Olivine HS285.4B | 9 | 7 | 1 | 6 | 9 | 0 | 9 | 0 | 1 | 9 | 9 | 0 | 9 | 4 | 4 | 2 | 3 | 4 | 5 | 6 | 4 | 3 | 3 | 4 | 6 | 5 | 6 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivine8.spc Olivine HS420.3B | 4 | 2 | 1 | 2 | 9 | 0 | 9 | 0 | 1 | 8 | 8 | 3 | 8 | 5 | 3 | 4 | 2 | 5 | 6 | 6 | 3 | 4 | 4 | 3 | 7 | 7 | 5 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivine9.spc Olivine KI3005 < | 8 | 8 | 7 | 8 | 9 | 2 | 9 | 0 | 3 | 7 | 9 | 0 | 9 | 4 | 4 | 4 | 3 | 4 | 6 | 5 | 2 | 1 | 2 | 3 | 7 | 5 | 7 | 5 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivinea.spc Olivine KI3054 < | 8 | 7 | 5 | 6 | 9 | 0 | 9 | 0 | 1 | 8 | 9 | 1 | 9 | 3 | 3 | 3 | 2 | 3 | 6 | 4 | 2 | 1 | 1 | 3 | 6 | 6 | 6 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivineb.spc Olivine KI3188 < | 8 | 6 | 5 | 6 | 9 | 1 | 9 | 0 | 2 | 8 | 9 | 1 | 9 | 5 | 3 | 4 | 2 | 3 | 5 | 4 | 3 | 2 | 2 | 3 | 7 | 7 | 6 | 8 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivinec.spc Olivine KI3189 < | 7 | 6 | 5 | 6 | 9 | 1 | 9 | 0 | 2 | 8 | 9 | 1 | 9 | 6 | 2 | 5 | 3 | 4 | 6 | 3 | 3 | 3 | 3 | 4 | 5 | 5 | 5 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivined.spc Olivine KI3291 < | 9 | 8 | 7 | 8 | 9 | 1 | 9 | 0 | 3 | 8 | 9 | 0 | 9 | 4 | 5 | 4 | 3 | 5 | 6 | 5 | 3 | 1 | 2 | 3 | 6 | 6 | 7 | 7 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivinee.spc Olivine KI3377 < | 8 | 7 | 7 | 7 | 9 | 1 | 9 | 0 | 4 | 7 | 9 | 0 | 9 | 4 | 5 | 3 | 3 | 5 | 5 | 4 | 3 | 1 | 2 | 2 | 7 | 6 | 7 | 6 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivinef.spc Olivine KI4143 < | 8 | 7 | 6 | 7 | 9 | 1 | 9 | 0 | 2 | 7 | 9 | 0 | 9 | 5 | 3 | 4 | 3 | 4 | 6 | 5 | 4 | 1 | 1 | 3 | 6 | 6 | 7 | 6 | 9 | 9 | 9 | 9 | 9 | 9 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| olivineg.spc Olivine GDS71.a | 5 | 3 | 1 | 2 | 9 | 0 | 9 | 0 | 0 | 9 | 8 | 2 | 8 | 4 | 3 | 4 | 4 | 5 | 5 | 3 | 4 | 3 | 3 | 3 | 7 | 6 | 6 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| olivineh.spc Olivine GDS71.b | 3 | 3 | 2 | 3 | 8 | 1 | 8 | 1 | 2 | 7 | 5 | 6 | 6 | 5 | 4 | 4 | 3 | 5 | 5 | 4 | 4 | 2 | 3 | 3 | 6 | 6 | 6 | 9 | 9 | 8 | 7 | 8 | 8 | 8 |
| opal1.spc Opal WS732~~10 | 7 | 7 | 7 | 7 | 8 | 4 | 9 | 1 | 9 | 0 | 8 | 9 | 9 | 0 | 9 | 0 | 9 | 6 | 0 | 0 | 1 | 0 | 0 | 6 | 8 | 0 | 9 | 6 | 9 | 0 | 0 | 0 | 0 | 0 |
| opal2.spc Opal TM8896 (Hya | 3 | 4 | 5 | 4 | 4 | 5 | 3 | 5 | 6 | 1 | 3 | 7 | 4 | 2 | 7 | 3 | 7 | 3 | 0 | 1 | 1 | 0 | 0 | 4 | 7 | 5 | 7 | 6 | 5 | 1 | 1 | 2 | 1 | 3 |
| orthocl1.spc Orthoclase NMN | 2 | 2 | 2 | 2 | 4 | 1 | 3 | 2 | 6 | 4 | 3 | 3 | 3 | 5 | 2 | 4 | 4 | 4 | 6 | 5 | 2 | 1 | 2 | 3 | 6 | 5 | 7 | 7 | 5 | 5 | 5 | 5 | 6 | 7 |
| orthocl2.spc Orthoclase NMN | 2 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 8 | 3 | 4 | 4 | 3 | 5 | 3 | 4 | 3 | 3 | 5 | 4 | 2 | 2 | 2 | 3 | 6 | 6 | 5 | 7 | 7 | 4 | 5 | 5 | 6 | 7 |
| orthocl3.spc Orthoclase HS1 | 3 | 4 | 4 | 4 | 5 | 4 | 5 | 4 | 6 | 2 | 4 | 4 | 3 | 7 | 3 | 8 | 3 | 1 | 8 | 8 | 1 | 4 | 4 | 5 | 4 | 4 | 3 | 6 | 6 | 3 | 3 | 3 | 4 | 4 |
| palygor1.spc Palygorskite CM | 6 | 6 | 4 | 5 | 4 | 4 | 6 | 6 | 8 | 2 | 5 | 7 | 5 | 1 | 8 | 3 | 7 | 6 | 0 | 0 | 6 | 8 | 8 | 8 | 1 | 1 | 1 | 4 | 7 | 5 | 3 | 2 | 3 | 2 |
| palygor2.spc Palygorskite PF | 6 | 5 | 4 | 5 | 4 | 5 | 6 | 6 | 7 | 2 | 5 | 6 | 6 | 1 | 8 | 2 | 7 | 6 | 0 | 0 | 6 | 7 | 8 | 8 | 1 | 1 | 1 | 4 | 6 | 4 | 3 | 2 | 3 | 2 |
| paragoni.spc Paragonite GDS | 8 | 6 | 7 | 8 | 2 | 7 | 3 | 6 | 4 | 5 | 3 | 4 | 3 | 9 | 2 | 8 | 9 | 1 | 9 | 9 | 6 | 9 | 9 | 7 | 3 | 3 | 1 | 2 | 3 | 5 | 5 | 4 | 3 | 2 |
| pectoli1.spc Pectolite NMNH | 4 | 2 | 2 | 2 | 4 | 3 | 4 | 4 | 7 | 1 | 0 | 9 | 0 | 9 | 0 | 9 | 8 | 7 | 1 | 3 | 6 | 6 | 5 | 6 | 3 | 3 | 5 | 6 | 7 | 1 | 0 | 0 | 0 | 0 |
| pectoli2.spc Pectolite NMNH | 3 | 3 | 3 | 3 | 5 | 4 | 5 | 4 | 7 | 3 | 0 | 9 | 0 | 9 | 0 | 8 | 8 | 7 | 2 | 2 | 6 | 5 | 4 | 5 | 3 | 3 | 5 | 7 | 6 | 2 | 1 | 1 | 0 | 1 |
| perthite.spc Perthite HS415.3 | 5 | 8 | 9 | 7 | 3 | 7 | 3 | 5 | 6 | 4 | 4 | 4 | 3 | 5 | 3 | 4 | 3 | 2 | 4 | 5 | 3 | 3 | 3 | 5 | 4 | 4 | 5 | 2 | 4 | 4 | 4 | 4 | 5 | 6 |
| phalite.spc Polyhalite NMNH | 4 | 8 | 8 | 7 | 5 | 7 | 3 | 4 | 7 | 1 | 2 | 2 | 6 | 0 | 5 | 0 | 1 | 3 | 4 | 3 | 1 | 5 | 6 | 9 | 0 | 0 | 1 | 3 | 5 | 1 | 2 | 1 | 2 | 2 |
| phlogop1.spc Phlogopite GDS | 5 | 8 | 8 | 7 | 3 | 7 | 1 | 3 | 5 | 6 | 5 | 2 | 5 | 7 | 2 | 7 | 2 | 8 | 4 | 3 | 8 | 8 | 8 | 1 | 8 | 8 | 8 | 2 | 3 | 7 | 7 | 7 | 7 | 5 |
| phlogop2.spc Phlogopite HS2 | 6 | 8 | 8 | 8 | 1 | 8 | 1 | 7 | 5 | 6 | 7 | 1 | 7 | 7 | 1 | 8 | 1 | 9 | 3 | 2 | 9 | 9 | 9 | 0 | 8 | 8 | 8 | 2 | 2 | 7 | 8 | 8 | 8 | 6 |
| phlogop3.spc Phlogopite WS | 5 | 4 | 3 | 4 | 3 | 1 | 3 | 7 | 4 | 6 | 7 | 2 | 6 | 7 | 1 | 7 | 1 | 9 | 3 | 2 | 9 | 9 | 9 | 1 | 8 | 8 | 8 | 4 | 3 | 7 | 8 | 8 | 8 | 6 |
| phlogop4.spc Phlogopite WS | 6 | 6 | 6 | 6 | 2 | 7 | 2 | 7 | 6 | 6 | 6 | 2 | 7 | 5 | 4 | 6 | 1 | 8 | 4 | 3 | 8 | 8 | 8 | 1 | 8 | 8 | 8 | 2 | 3 | 7 | 7 | 7 | 8 | 7 |
| pigeonit.spc Pigeonite HS199 | 4 | 5 | 4 | 4 | 8 | 5 | 8 | 3 | 2 | 6 | 1 | 8 | 1 | 3 | 4 | 6 | 1 | 2 | 6 | 7 | 3 | 3 | 2 | 2 | 6 | 8 | 4 | 6 | 8 | 6 | 5 | 5 | 6 | 7 |
| pinnoite.spc Pinnoite NMNH1 | 1 | 2 | 2 | 2 | 6 | 2 | 6 | 2 | 8 | 0 | 6 | 2 | 6 | 9 | 5 | 9 | 0 | 1 | 7 | 8 | 0 | 5 | 6 | 9 | 1 | 1 | 2 | 8 | 7 | 0 | 0 | 0 | 0 | 0 |
| plimonit.spc Pitch_Limonite ( | 9 | 9 | 8 | 7 | 0 | 0 | 0 | 7 | 0 | 9 | 8 | 4 | 8 | 1 | 9 | 1 | 5 | 7 | 1 | 1 | 6 | 0 | 1 | 8 | 2 | 1 | 3 | 0 | 0 | 8 | 8 | 7 | 6 | 5 |
| praseody.spc Praseodymium | 2 | 7 | 8 | 8 | 0 | 9 | 0 | 8 | 0 | 9 | 1 | 0 | 1 | 0 | 9 | 0 | 4 | 7 | 6 | 6 | 7 | 8 | 8 | 1 | 7 | 9 | 1 | 0 | 0 | 8 | 9 | 9 | 9 | 9 |
| prochlo1.spc Prochlorite SMF | 5 | 0 | 0 | 0 | 7 | 0 | 6 | 7 | 3 | 8 | 8 | 0 | 8 | 2 | 8 | 2 | 2 | 9 | 2 | 1 | 8 | 7 | 2 | 0 | 9 | 9 | 9 | 6 | 2 | 9 | 9 | 9 | 9 | 9 |
| prochlo2.spc Prochlorite SMF | 7 | 0 | 0 | 1 | 2 | 1 | 2 | 9 | 1 | 9 | 8 | 0 | 8 | 2 | 6 | 2 | 5 | 7 | 2 | 2 | 7 | 7 | 5 | 1 | 8 | 9 | 3 | 3 | 1 | 9 | 9 | 9 | 9 | 9 |
| prochlo3.spc Prochlorite SMF | 8 | 4 | 2 | 5 | 1 | 2 | 1 | 8 | 3 | 7 | 8 | 2 | 7 | 5 | 7 | 5 | 3 | 7 | 4 | 3 | 6 | 4 | 6 | 1 | 7 | 8 | 7 | 2 | 2 | 8 | 8 | 8 | 8 | 8 |
| psilomel.spc Psilomelane HS | 0 | 0 | 1 | 0 | 2 | 2 | 1 | 3 | 4 | 5 | 2 | 1 | 6 | 2 | 2 | 0 | 4 | 2 | 9 | 7 | 1 | 2 | 0 | 2 | 5 | 6 | 8 | 9 | 4 | 6 | 7 | 7 | 8 | 8 |
| pyrite1.spc Pyrite HS35.3~~1 | 7 | 5 | 5 | 6 | 8 | 2 | 8 | 1 | 8 | 1 | 1 | 5 | 1 | 6 | 3 | 2 | 3 | 2 | 7 | 5 | 2 | 3 | 3 | 4 | 4 | 6 | 3 | 6 | 9 | 2 | 3 | 3 | 5 | 6 |
| pyrite2.spc Pyrite S142-1~~1 | 4 | 4 | 5 | 5 | 2 | 6 | 1 | 5 | 2 | 7 | 1 | 4 | 5 | 6 | 2 | 6 | 2 | 3 | 6 | 7 | 4 | 2 | 3 | 2 | 6 | 7 | 7 | 3 | 2 | 6 | 7 | 7 | 7 | 8 |
| pyrite3.spc Pyrite S26-8~~14 | 6 | 5 | 5 | 6 | 7 | 6 | 6 | 1 | 1 | 9 | 5 | 2 | 7 | 4 | 1 | 5 | 1 | 4 | 6 | 5 | 4 | 1 | 1 | 2 | 7 | 5 | 8 | 2 | 1 | 8 | 8 | 8 | 9 | 9 |
| pyrite4.spc Pyrite S29-4~~15 | 5 | 4 | 4 | 6 | 7 | 5 | 3 | 1 | 1 | 9 | 7 | 3 | 7 | 4 | 1 | 2 | 2 | 2 | 6 | 5 | 2 | 2 | 2 | 3 | 4 | 7 | 3 | 3 | 1 | 9 | 9 | 9 | 9 | 9 |
| pyrite5.spc Pyrite S30~~16 | 4 | 4 | 4 | 5 | 8 | 5 | 6 | 1 | 1 | 8 | 5 | 3 | 6 | 4 | 5 | 5 | 1 | 2 | 5 | 6 | 2 | 1 | 2 | 3 | 5 | 4 | 7 | 3 | 1 | 8 | 8 | 8 | 8 | 8 |
| pyrope.spc Pyrope WS474~~ | 8 | 8 | 8 | 9 | 1 | 9 | 1 | 7 | 5 | 5 | 1 | 6 | 3 | 4 | 4 | 3 | 3 | 4 | 5 | 6 | 3 | 3 | 2 | 4 | 5 | 5 | 6 | 0 | 2 | 5 | 5 | 6 | 7 | 7 |
| pyrophy1.spc Pyrophyllite PY | 2 | 3 | 3 | 3 | 5 | 4 | 3 | 3 | 6 | 3 | 2 | 5 | 1 | 9 | 1 | 6 | 9 | 8 | 9 | 5 | 8 | 7 | 5 | 2 | 8 | 3 | 9 | 7 | 5 | 3 | 4 | 4 | 3 | 2 |
| pyrophy2.spc Pyrophyllite PY | 4 | 5 | 5 | 5 | 1 | 7 | 1 | 7 | 4 | 4 | 4 | 6 | 3 | 9 | 1 | 8 | 9 | 9 | 9 | 4 | 9 | 8 | 6 | 2 | 8 | 2 | 9 | 3 | 2 | 4 | 4 | 3 | 1 | 1 |
| pyrophy3.spc Pyrophyllite SU | 2 | 2 | 2 | 3 | 3 | 4 | 3 | 4 | 6 | 4 | 6 | 8 | 5 | 8 | 8 | 8 | 9 | 7 | 9 | 8 | 8 | 8 | 6 | 5 | 8 | 2 | 8 | 7 | 5 | 5 | 5 | 4 | 2 | 2 |
| pyroxene.spc Pyroxene HS1 | 5 | 0 | 0 | 0 | 8 | 0 | 7 | 0 | 6 | 8 | 9 | 0 | 9 | 1 | 7 | 1 | 0 | 5 | 8 | 7 | 4 | 1 | 1 | 1 | 8 | 8 | 8 | 9 | 8 | 9 | 9 | 9 | 9 | 9 |
| pyrrhoti.spc Pyrrhotite HS269 | 8 | 9 | 8 | 8 | 2 | 6 | 6 | 6 | 2 | 6 | 2 | 3 | 2 | 5 | 2 | 3 | 2 | 5 | 4 | 4 | 2 | 3 | 2 | 3 | 6 | 5 | 7 | 1 | 3 | 6 | 6 | 6 | 7 | 7 |
| quartz1.spc Quartz HS117.3B | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 9 | 4 | 4 | 1 | 8 | 1 | 8 | 1 | 7 | 8 | 2 | 3 | 8 | 2 | 4 | 5 | 6 | 3 | 4 | 2 | 6 | 1 | 2 | 2 | 2 | 2 | 3 |
| quartz2.spc Quartz GDS31 0 | 1 | 2 | 3 | 1 | 4 | 3 | 3 | 3 | 5 | 4 | 3 | 4 | 2 | 5 | 2 | 3 | 4 | 3 | 6 | 5 | 3 | 2 | 3 | 3 | 5 | 6 | 5 | 7 | 5 | 4 | 4 | 5 | 6 | 6 |
| quartz3.spc Quartz HS32.4B | 2 | 2 | 3 | 2 | 4 | 3 | 4 | 4 | 6 | 3 | 2 | 4 | 2 | 5 | 2 | 3 | 3 | 3 | 5 | 5 | 2 | 2 | 2 | 4 | 5 | 6 | 5 | 7 | 5 | 3 | 4 | 5 | 6 | 6 |
| quartz4.spc Quartz GDS74 S | 4 | 6 | 6 | 5 | 1 | 7 | 1 | 7 | 4 | 5 | 3 | 3 | 4 | 3 | 5 | 3 | 3 | 3 | 5 | 5 | 3 | 2 | 3 | 4 | 5 | 5 | 6 | 3 | 2 | 5 | 5 | 5 | 6 | 6 |
| rectori1.spc Rectorite ISR202 | 8 | 8 | 8 | 8 | 4 | 6 | 5 | 5 | 4 | 2 | 3 | 7 | 4 | 2 | 7 | 3 | 8 | 2 | 8 | 8 | 6 | 6 | 6 | 7 | 2 | 3 | 2 | 1 | 4 | 2 | 2 | 2 | 2 | 2 |
| rectori2.spc Rectorite RAr-1~ | 8 | 7 | 6 | 7 | 4 | 6 | 6 | 6 | 6 | 3 | 4 | 5 | 1 | 4 | 4 | 4 | 8 | 3 | 8 | 8 | 5 | 5 | 6 | 6 | 4 | 4 | 3 | 2 | 6 | 2 | 3 | 3 | 4 | 4 |
| rhodoch1.spc Rhodochrosite | 2 | 7 | 9 | 7 | 7 | 7 | 7 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 7 | 5 | 7 | 8 | 4 | 2 | 8 | 9 | 8 | 0 | 1 | 9 | 1 | 4 | 8 | 6 | 6 | 5 | 4 | 5 |
| rhodoch2.spc Rhodochrosite | 0 | 6 | 8 | 6 | 8 | 6 | 8 | 2 | 5 | 5 | 7 | 3 | 7 | 4 | 6 | 4 | 6 | 7 | 4 | 2 | 7 | 7 | 7 | 1 | 2 | 9 | 2 | 8 | 8 | 7 | 7 | 7 | 6 | 6 |
| rhodoni1.spc Rhodonite NMN | 1 | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 0 | 8 | 6 | 2 | 5 | 6 | 4 | 6 | 6 | 6 | 3 | 3 | 5 | 4 | 3 | 5 | 4 | 4 | 5 | 2 | 9 | 7 | 8 | 7 | 7 | 7 |
| rhodoni2.spc Rhodonite HS3 | 0 | 8 | 9 | 8 | 8 | 8 | 9 | 4 | 1 | 7 | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 6 | 3 | 4 | 5 | 4 | 5 | 4 | 4 | 7 | 4 | 4 | 8 | 6 | 6 | 5 | 5 | 5 |
| richter1.spc Richterite HS336 | 8 | 8 | 8 | 8 | 1 | 8 | 2 | 7 | 6 | 3 | 1 | 6 | 3 | 6 | 3 | 5 | 5 | 7 | 6 | 6 | 8 | 5 | 4 | 1 | 8 | 6 | 9 | 1 | 4 | 3 | 3 | 4 | 4 | 5 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| richter2.spc Richterite NMNH | 3 | 4 | 5 | 4 | 2 | 7 | 4 | 7 | 2 | 7 | 5 | 3 | 5 | 7 | 2 | 7 | 2 | 7 | 4 | 4 | 8 | 5 | 3 | 1 | 8 | 4 | 9 | 4 | 3 | 7 | 7 | 7 | 7 | 7 |
| riebeck1.spc Riebeckite NMN | 3 | 0 | 0 | 0 | 0 | 8 | 0 | 9 | 0 | 9 | 9 | 0 | 9 | 4 | 4 | 3 | 2 | 5 | 6 | 6 | 5 | 7 | 8 | 4 | 6 | 8 | 0 | 1 | 0 | 9 | 9 | 9 | 9 | 9 |
| riebeck2.spc Riebeckite HS3 | 4 | 1 | 1 | 2 | 3 | 3 | 3 | 7 | 2 | 8 | 8 | 1 | 8 | 6 | 5 | 5 | 7 | 7 | 3 | 8 | 7 | 8 | 9 | 2 | 4 | 8 | 1 | 4 | 2 | 9 | 9 | 9 | 9 | 9 |
| rivadavi.spc Rivadavite NMNH | 2 | 5 | 5 | 3 | 6 | 3 | 8 | 4 | 9 | 0 | 6 | 9 | 6 | 9 | 6 | 9 | 9 | 0 | 9 | 9 | 0 | 1 | 5 | 9 | 0 | 0 | 0 | 8 | 8 | 0 | 0 | 0 | 0 | 0 |
| roscoeli.spc Roscoelite EN12 | 6 | 1 | 1 | 7 | 0 | 8 | 2 | 9 | 7 | 3 | 6 | 1 | 6 | 6 | 4 | 7 | 7 | 1 | 1 | 7 | 0 | 4 | 6 | 6 | 2 | 3 | 2 | 2 | 4 | 5 | 6 | 6 | 6 | 5 |
| rutile1.spc Rutile HS126.3B~ | 6 | 9 | 9 | 9 | 0 | 9 | 0 | 9 | 8 | 2 | 3 | 2 | 4 | 3 | 5 | 4 | 2 | 5 | 4 | 4 | 6 | 1 | 1 | 2 | 7 | 5 | 8 | 0 | 1 | 4 | 5 | 6 | 7 | 7 |
| rutile2.spc Rutile HS137.3B~ | 4 | 8 | 8 | 8 | 0 | 9 | 0 | 9 | 0 | 8 | 3 | 5 | 3 | 4 | 3 | 4 | 5 | 6 | 6 | 6 | 6 | 4 | 2 | 5 | 5 | 3 | 7 | 0 | 0 | 7 | 7 | 7 | 7 | 7 |
| samarium.spc Samarium_Ox | 3 | 2 | 3 | 3 | 7 | 2 | 8 | 2 | 9 | 0 | 9 | 0 | 9 | 1 | 7 | 2 | 1 | 7 | 5 | 3 | 7 | 6 | 6 | 6 | 3 | 3 | 3 | 9 | 9 | 0 | 6 | 4 | 6 | 4 |
| sanidin1.spc Sanidine GDS1 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 5 | 4 | 4 | 2 | 5 | 2 | 5 | 2 | 4 | 4 | 3 | 6 | 5 | 3 | 2 | 2 | 3 | 6 | 6 | 6 | 7 | 3 | 4 | 5 | 5 | 6 | 6 |
| sanidin2.spc Sanidine NMNH | 2 | 3 | 3 | 3 | 6 | 4 | 6 | 3 | 4 | 5 | 3 | 4 | 3 | 5 | 2 | 4 | 3 | 4 | 5 | 4 | 3 | 2 | 2 | 3 | 6 | 6 | 6 | 6 | 4 | 4 | 5 | 5 | 6 | 6 |
| saponit1.spc Saponite SapCa | 8 | 5 | 4 | 6 | 7 | 6 | 8 | 3 | 7 | 1 | 8 | 9 | 8 | 0 | 9 | 1 | 2 | 9 | 4 | 2 | 9 | 9 | 3 | 1 | 9 | 1 | 9 | 3 | 8 | 1 | 0 | 1 | 1 | 1 |
| saponit2.spc Saponite SapCa | 6 | 5 | 4 | 6 | 7 | 5 | 7 | 3 | 5 | 2 | 6 | 9 | 6 | 1 | 9 | 6 | 2 | 9 | 3 | 2 | 9 | 8 | 1 | 0 | 9 | 1 | 9 | 4 | 7 | 3 | 1 | 1 | 2 | 1 |
| sauconit.spc Sauconite GDS | 9 | 9 | 9 | 9 | 6 | 8 | 6 | 6 | 3 | 1 | 8 | 8 | 8 | 0 | 9 | 0 | 1 | 8 | 3 | 3 | 8 | 9 | 9 | 8 | 2 | 6 | 0 | 0 | 3 | 1 | 1 | 1 | 1 | 1 |
| sbicarbo.spc Sodium_Bicarb | 1 | 1 | 1 | 1 | 6 | 2 | 4 | 2 | 8 | 0 | 0 | 9 | 0 | 8 | 0 | 6 | 8 | 7 | 0 | 1 | 7 | 6 | 1 | 5 | 7 | 5 | 6 | 9 | 7 | 0 | 0 | 0 | 0 | 0 |
| scolecit.spc Scolecite GDS7 | 1 | 4 | 4 | 2 | 7 | 2 | 7 | 2 | 9 | 0 | 0 | 3 | 5 | 0 | 7 | 0 | 7 | 5 | 8 | 7 | 4 | 6 | 7 | 9 | 0 | 0 | 1 | 9 | 8 | 0 | 1 | 0 | 1 | 0 |
| sepioli1.spc Sepiolite SepNe | 3 | 5 | 6 | 4 | 4 | 5 | 5 | 3 | 8 | 1 | 7 | 7 | 7 | 0 | 9 | 1 | 4 | 8 | 3 | 2 | 9 | 7 | 4 | 7 | 7 | 0 | 9 | 6 | 7 | 1 | 1 | 1 | 1 | 1 |
| sepioli2.spc Sepiolite SepNe | 2 | 4 | 5 | 3 | 5 | 4 | 6 | 3 | 8 | 1 | 6 | 8 | 7 | 1 | 9 | 2 | 4 | 8 | 3 | 2 | 8 | 7 | 4 | 7 | 7 | 0 | 9 | 7 | 7 | 1 | 1 | 1 | 1 | 1 |
| sepioli3.spc Sepiolite SepSp | 5 | 7 | 7 | 7 | 1 | 8 | 1 | 7 | 5 | 1 | 7 | 7 | 7 | 0 | 9 | 1 | 5 | 8 | 3 | 3 | 8 | 7 | 5 | 7 | 8 | 0 | 9 | 2 | 2 | 1 | 1 | 1 | 2 | 1 |
| sepioli4.spc Sepiolite SepSp | 5 | 7 | 7 | 7 | 0 | 8 | 1 | 8 | 5 | 1 | 6 | 8 | 7 | 0 | 9 | 1 | 2 | 8 | 2 | 2 | 8 | 7 | 5 | 7 | 7 | 0 | 9 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| serpent1.spc Serpentine HS3 | 7 | 5 | 1 | 7 | 8 | 2 | 8 | 5 | 8 | 2 | 1 | 7 | 3 | 3 | 8 | 9 | 0 | 9 | 1 | 0 | 9 | 9 | 9 | 0 | 9 | 9 | 0 | 6 | 9 | 5 | 3 | 2 | 1 | 1 |
| serpent2.spc Serpentine HS8 | 3 | 0 | 0 | 0 | 6 | 0 | 7 | 6 | 7 | 5 | 4 | 4 | 2 | 6 | 6 | 8 | 3 | 9 | 3 | 2 | 9 | 9 | 9 | 1 | 9 | 9 | 7 | 9 | 7 | 6 | 6 | 5 | 3 | 3 |
| siderite.spc Siderite HS271.3 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 4 | 9 | 9 | 0 | 9 | 2 | 7 | 2 | 4 | 7 | 3 | 2 | 7 | 7 | 7 | 2 | 6 | 8 | 3 | 1 | 9 | 9 | 9 | 9 | 9 | 9 |
| sideroph.spc Siderophyllite N | 7 | 1 | 1 | 3 | 2 | 1 | 3 | 7 | 4 | 8 | 9 | 0 | 9 | 2 | 6 | 1 | 1 | 3 | 7 | 6 | 2 | 2 | 4 | 5 | 3 | 4 | 3 | 4 | 3 | 9 | 9 | 9 | 9 | 9 |
| silliman.spc Sillimanite HS18 | 4 | 3 | 4 | 4 | 5 | 5 | 4 | 4 | 7 | 2 | 1 | 5 | 1 | 7 | 4 | 7 | 8 | 2 | 8 | 8 | 5 | 6 | 6 | 6 | 4 | 3 | 3 | 5 | 6 | 2 | 3 | 3 | 3 | 3 |
| smaragdi.spc Smaragdite HS | 6 | 0 | 0 | 3 | 1 | 6 | 6 | 9 | 0 | 9 | 7 | 2 | 8 | 8 | 1 | 8 | 5 | 9 | 3 | 3 | 9 | 9 | 8 | 0 | 9 | 7 | 9 | 2 | 0 | 9 | 9 | 8 | 8 | 7 |
| spessar1.spc Spessartine NI | 8 | 9 | 9 | 8 | 0 | 9 | 8 | 9 | 9 | 0 | 0 | 2 | 0 | 7 | 2 | 7 | 7 | 7 | 3 | 2 | 4 | 5 | 6 | 2 | 6 | 8 | 4 | 6 | 9 | 7 | 7 | 8 | 7 | 7 |
| spessar2.spc Spessartine HS | 9 | 9 | 9 | 9 | 1 | 9 | 7 | 9 | 9 | 0 | 0 | 4 | 0 | 7 | 4 | 6 | 6 | 6 | 3 | 4 | 4 | 3 | 4 | 5 | 4 | 5 | 5 | 1 | 9 | 7 | 7 | 7 | 7 | 7 |
| spessar3.spc Spessartine W | 5 | 8 | 8 | 7 | 1 | 8 | 5 | 8 | 9 | 0 | 0 | 6 | 1 | 6 | 2 | 5 | 5 | 4 | 4 | 6 | 1 | 3 | 3 | 3 | 5 | 7 | 3 | 5 | 9 | 5 | 5 | 6 | 6 | 7 |
| spessar4.spc Spessartine W | 8 | 8 | 8 | 8 | 3 | 7 | 3 | 6 | 5 | 4 | 4 | 3 | 4 | 5 | 3 | 3 | 4 | 3 | 5 | 4 | 3 | 2 | 3 | 4 | 4 | 6 | 5 | 1 | 4 | 4 | 5 | 6 | 7 | 7 |
| sphaler1.spc Sphalerite HS1 | 9 | 7 | 6 | 8 | 1 | 7 | 1 | 8 | 7 | 4 | 5 | 2 | 4 | 9 | 0 | 9 | 8 | 8 | 0 | 0 | 8 | 7 | 6 | 8 | 2 | 2 | 2 | 1 | 4 | 5 | 5 | 2 | 0 | 0 |
| sphaler2.spc Sphalerite S102 | 7 | 8 | 7 | 7 | 0 | 8 | 2 | 8 | 5 | 5 | 6 | 0 | 6 | 9 | 0 | 9 | 8 | 8 | 1 | 1 | 6 | 7 | 7 | 8 | 2 | 2 | 3 | 2 | 3 | 6 | 7 | 6 | 1 | 2 |
| sphaler3.spc Sphalerite S102 | 8 | 9 | 9 | 8 | 0 | 9 | 0 | 9 | 4 | 5 | 5 | 1 | 5 | 9 | 0 | 9 | 9 | 8 | 0 | 0 | 8 | 8 | 7 | 8 | 1 | 2 | 0 | 0 | 2 | 5 | 6 | 2 | 0 | 0 |
| sphaler4.spc Sphalerite S26- | 8 | 9 | 9 | 9 | 0 | 9 | 0 | 9 | 5 | 1 | 2 | 2 | 2 | 9 | 0 | 9 | 9 | 8 | 0 | 0 | 8 | 8 | 8 | 8 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| sphaler5.spc Sphalerite S26- | 8 | 9 | 9 | 9 | 0 | 9 | 0 | 9 | 5 | 1 | 1 | 2 | 2 | 9 | 0 | 9 | 9 | 8 | 0 | 1 | 9 | 8 | 6 | 8 | 1 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| sphene.spc Sphene HS189.3 | 5 | 8 | 9 | 8 | 0 | 9 | 0 | 9 | 3 | 6 | 5 | 3 | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 6 | 3 | 3 | 4 | 4 | 6 | 5 | 6 | 1 | 1 | 6 | 7 | 7 | 7 | 8 |
| spodumen.spc Spodumene H | 5 | 4 | 5 | 5 | 8 | 4 | 7 | 2 | 3 | 5 | 2 | 3 | 1 | 3 | 6 | 5 | 7 | 2 | 4 | 8 | 3 | 5 | 5 | 6 | 3 | 3 | 3 | 5 | 6 | 3 | 5 | 6 | 6 | 5 |
| stauroli.spc Staurolite HS188 | 8 | 9 | 9 | 8 | 2 | 8 | 4 | 7 | 9 | 0 | 0 | 7 | 0 | 4 | 1 | 7 | 7 | 4 | 7 | 5 | 6 | 3 | 1 | 5 | 4 | 3 | 6 | 2 | 9 | 0 | 0 | 0 | 0 | 1 |
| stilbit1.spc Stilbite GDS8~~5 | 2 | 4 | 5 | 3 | 6 | 3 | 7 | 4 | 9 | 1 | 5 | 9 | 7 | 0 | 9 | 1 | 1 | 7 | 5 | 5 | 6 | 7 | 8 | 9 | 0 | 0 | 1 | 8 | 8 | 1 | 0 | 1 | 1 | 1 |
| stilbit2.spc Stilbite HS482.3B | 7 | 8 | 8 | 7 | 5 | 6 | 8 | 5 | 9 | 0 | 7 | 9 | 8 | 0 | 9 | 0 | 0 | 7 | 6 | 4 | 7 | 9 | 9 | 9 | 0 | 0 | 0 | 3 | 8 | 0 | 0 | 0 | 0 | 0 |
| strontia.spc Strontianite HS2 | 2 | 2 | 2 | 2 | 5 | 2 | 3 | 2 | 6 | 3 | 2 | 6 | 1 | 4 | 5 | 6 | 8 | 8 | 5 | 1 | 8 | 9 | 9 | 0 | 2 | 9 | 0 | 7 | 6 | 3 | 3 | 3 | 3 | 4 |
| sulfur.spc Sulfur GDS94 Rea | 9 | 6 | 5 | 9 | 7 | 3 | 6 | 2 | 7 | 2 | 2 | 5 | 2 | 6 | 2 | 4 | 3 | 4 | 5 | 4 | 2 | 2 | 2 | 3 | 6 | 6 | 6 | 0 | 7 | 2 | 3 | 4 | 5 | 6 |
| syngenit.spc Syngenite GDS | 2 | 1 | 1 | 2 | 6 | 3 | 4 | 2 | 6 | 1 | 6 | 1 | 4 | 0 | 9 | 0 | 0 | 1 | 8 | 8 | 2 | 5 | 5 | 7 | 6 | 3 | 3 | 7 | 6 | 1 | 2 | 1 | 3 | 3 |
| talc1.spc Talc GDS23 74-250 | 5 | 3 | 2 | 3 | 6 | 2 | 2 | 1 | 3 | 6 | 5 | 3 | 4 | 9 | 6 | 8 | 7 | 9 | 2 | 0 | 9 | 6 | 0 | 0 | 9 | 0 | 9 | 4 | 3 | 5 | 5 | 4 | 2 | 1 |
| talc2.spc Talc HS21.3B~~11 | 3 | 2 | 2 | 2 | 8 | 1 | 6 | 1 | 3 | 5 | 7 | 3 | 5 | 6 | 6 | 8 | 5 | 9 | 2 | 0 | 9 | 6 | 0 | 0 | 9 | 3 | 9 | 7 | 5 | 5 | 4 | 4 | 2 | 3 |
| talc3.spc Talc WS659~~12 | 1 | 3 | 3 | 2 | 8 | 2 | 7 | 2 | 4 | 4 | 2 | 6 | 2 | 7 | 4 | 7 | 5 | 9 | 3 | 1 | 9 | 3 | 0 | 0 | 9 | 1 | 9 | 8 | 6 | 2 | 3 | 3 | 2 | 3 |
| talc4.spc Talc TL2702~~13 | 2 | 2 | 2 | 2 | 7 | 1 | 5 | 1 | 4 | 4 | 4 | 6 | 4 | 8 | 5 | 8 | 5 | 9 | 3 | 0 | 9 | 4 | 0 | 0 | 9 | 1 | 9 | 7 | 5 | 3 | 3 | 3 | 2 | 3 |
| teepleit.spc Teepleite+Tron N | 7 | 6 | 6 | 7 | 3 | 6 | 4 | 5 | 9 | 0 | 0 | 9 | 0 | 8 | 0 | 7 | 0 | 4 | 3 | 1 | 1 | 0 | 0 | 8 | 1 | 1 | 2 | 3 | 7 | 0 | 0 | 0 | 0 | 0 |
| tephroit.spc Tephroite HS419 | 6 | 8 | 8 | 8 | 9 | 9 | 9 | 0 | 5 | 8 | 9 | 1 | 9 | 6 | 3 | 5 | 4 | 6 | 5 | 6 | 6 | 4 | 4 | 2 | 4 | 8 | 4 | 5 | 9 | 9 | 9 | 9 | 9 | 9 |

| Hyp. Ratio Codes | R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) | R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) | R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) | R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| thenard1.spc Thenardite GDS | 7 | 7 | 6 | 7 | 3 | 6 | 3 | 6 | 4 | 5 | 3 | 5 | 3 | 3 | 7 | 7 | 1 | 3 | 7 | 6 | 2 | 4 | 4 | 6 | 2 | 3 | 3 | 3 | 4 | 5 | 5 | 3 | 5 | 4 |
| thenard2.spc Thenardite HS4 | 2 | 3 | 3 | 2 | 5 | 3 | 4 | 4 | 6 | 3 | 2 | 4 | 2 | 5 | 3 | 4 | 4 | 4 | 5 | 4 | 2 | 2 | 3 | 4 | 5 | 6 | 5 | 7 | 6 | 3 | 4 | 4 | 5 | 6 |
| thuring1.spc Thuringite SMR- | 7 | 3 | 1 | 3 | 6 | 0 | 7 | 4 | 3 | 9 | 9 | 0 | 9 | 1 | 8 | 1 | 4 | 9 | 1 | 0 | 8 | 3 | 8 | 1 | 0 | 9 | 0 | 5 | 5 | 9 | 9 | 9 | 9 | 9 |
| thuring2.spc Thuringite SMR- | 8 | 1 | 0 | 3 | 7 | 0 | 7 | 6 | 1 | 9 | 9 | 0 | 9 | 1 | 8 | 1 | 2 | 8 | 1 | 1 | 7 | 4 | 8 | 1 | 1 | 9 | 0 | 3 | 2 | 9 | 9 | 9 | 9 | 9 |
| thuring3.spc Thuringite SMR- | 8 | 3 | 0 | 4 | 7 | 0 | 1 | 7 | 1 | 9 | 9 | 0 | 9 | 1 | 7 | 2 | 4 | 8 | 1 | 1 | 7 | 5 | 7 | 1 | 2 | 9 | 1 | 2 | 1 | 9 | 9 | 9 | 9 | 9 |
| thuring4.spc Thuringite SMR- | 8 | 4 | 2 | 5 | 1 | 2 | 1 | 8 | 3 | 7 | 8 | 2 | 7 | 6 | 6 | 6 | 2 | 7 | 4 | 3 | 6 | 5 | 6 | 2 | 6 | 8 | 7 | 2 | 2 | 8 | 8 | 8 | 8 | 8 |
| tincalco.spc Tincalconite GD | 1 | 1 | 2 | 1 | 7 | 2 | 7 | 2 | 9 | 0 | 1 | 8 | 0 | 2 | 7 | 2 | 4 | 6 | 5 | 1 | 4 | 3 | 3 | 8 | 4 | 1 | 6 | 9 | 8 | 0 | 0 | 0 | 0 | 0 |
| topaz1.spc Topaz Wigwam_A | 1 | 3 | 4 | 2 | 4 | 3 | 3 | 3 | 6 | 3 | 2 | 7 | 1 | 8 | 1 | 7 | 6 | 3 | 8 | 8 | 5 | 3 | 5 | 5 | 3 | 5 | 2 | 7 | 5 | 3 | 3 | 4 | 4 | 4 |
| topaz2.spc Topaz Wigwam_A | 1 | 3 | 4 | 1 | 5 | 3 | 3 | 3 | 5 | 4 | 2 | 7 | 2 | 7 | 2 | 6 | 4 | 5 | 7 | 7 | 4 | 3 | 4 | 5 | 4 | 4 | 4 | 7 | 4 | 4 | 4 | 5 | 5 | 5 |
| topaz3.spc Topaz Wigwam_A | 1 | 2 | 3 | 1 | 4 | 3 | 2 | 3 | 6 | 4 | 3 | 6 | 1 | 8 | 3 | 6 | 6 | 4 | 7 | 7 | 5 | 3 | 4 | 6 | 3 | 4 | 2 | 8 | 4 | 4 | 4 | 4 | 4 | 4 |
| topaz4.spc Topaz Wigwam_A | 0 | 1 | 2 | 1 | 5 | 2 | 4 | 3 | 6 | 3 | 1 | 5 | 2 | 7 | 2 | 5 | 5 | 4 | 7 | 7 | 4 | 3 | 4 | 4 | 4 | 5 | 5 | 8 | 6 | 3 | 4 | 5 | 5 | 5 |
| topaz5.spc Topaz Wigwam_A | 1 | 2 | 3 | 1 | 3 | 2 | 2 | 3 | 5 | 4 | 3 | 6 | 1 | 8 | 1 | 6 | 6 | 5 | 7 | 7 | 5 | 4 | 4 | 5 | 4 | 4 | 5 | 7 | 4 | 4 | 4 | 4 | 5 | 4 |
| topaz6.spc Topaz Wigwam_A | 0 | 1 | 2 | 0 | 4 | 2 | 2 | 3 | 7 | 4 | 3 | 7 | 2 | 7 | 3 | 7 | 6 | 4 | 7 | 7 | 5 | 4 | 5 | 5 | 4 | 5 | 4 | 8 | 4 | 4 | 4 | 5 | 5 | 5 |
| topaz7.spc Topaz Harris_Par | 1 | 3 | 4 | 2 | 6 | 3 | 5 | 3 | 6 | 3 | 3 | 7 | 2 | 7 | 1 | 6 | 6 | 4 | 7 | 7 | 5 | 4 | 5 | 5 | 4 | 4 | 4 | 8 | 6 | 3 | 3 | 4 | 4 | 4 |
| topaz8.spc Topaz Crystal_Pa | 1 | 1 | 3 | 1 | 3 | 3 | 2 | 3 | 6 | 4 | 2 | 6 | 1 | 8 | 1 | 6 | 6 | 5 | 8 | 8 | 5 | 4 | 5 | 6 | 3 | 3 | 3 | 7 | 4 | 3 | 4 | 4 | 4 | 4 |
| topaz9.spc Topaz Jos_#22~~ | 1 | 2 | 3 | 1 | 7 | 2 | 5 | 2 | 6 | 4 | 2 | 6 | 2 | 8 | 1 | 7 | 6 | 4 | 8 | 8 | 4 | 4 | 6 | 6 | 3 | 4 | 2 | 8 | 6 | 3 | 4 | 4 | 4 | 4 |
| topaza.spc Topaz Harris_Par | 1 | 2 | 4 | 1 | 7 | 3 | 4 | 2 | 6 | 3 | 4 | 6 | 1 | 8 | 2 | 7 | 6 | 5 | 8 | 7 | 4 | 3 | 6 | 5 | 4 | 4 | 6 | 8 | 6 | 4 | 4 | 4 | 4 | 4 |
| topazb.spc Topaz Tarryalls_# | 1 | 3 | 4 | 1 | 5 | 2 | 3 | 2 | 6 | 4 | 3 | 6 | 2 | 7 | 2 | 6 | 6 | 5 | 7 | 7 | 5 | 4 | 4 | 5 | 4 | 5 | 5 | 8 | 5 | 4 | 4 | 4 | 4 | 4 |
| topazc.spc Topaz Little_3_M | 1 | 1 | 2 | 1 | 4 | 2 | 2 | 3 | 5 | 4 | 1 | 5 | 2 | 8 | 2 | 7 | 6 | 3 | 8 | 7 | 5 | 4 | 6 | 5 | 3 | 4 | 2 | 8 | 4 | 4 | 5 | 5 | 5 | 5 |
| topazd.spc Topaz Cameron_ | 1 | 2 | 3 | 1 | 5 | 3 | 4 | 3 | 4 | 4 | 4 | 4 | 2 | 7 | 1 | 6 | 5 | 5 | 7 | 7 | 5 | 4 | 4 | 5 | 4 | 4 | 6 | 8 | 4 | 4 | 4 | 5 | 5 | 5 |
| topaze.spc Topaz Mt._Anterc | 1 | 2 | 4 | 1 | 6 | 3 | 5 | 2 | 7 | 3 | 2 | 7 | 2 | 8 | 1 | 9 | 3 | 6 | 7 | 5 | 5 | 5 | 6 | 7 | 3 | 3 | 2 | 8 | 7 | 3 | 3 | 4 | 3 | 3 |
| topazf.spc Topaz Glen_Cove_ | 1 | 2 | 3 | 1 | 7 | 3 | 5 | 2 | 6 | 3 | 2 | 6 | 2 | 7 | 2 | 6 | 6 | 4 | 8 | 7 | 5 | 3 | 4 | 5 | 4 | 4 | 4 | 8 | 6 | 4 | 4 | 4 | 4 | 4 |
| topazg.spc Topaz Glen_Cove | 1 | 4 | 5 | 2 | 6 | 4 | 4 | 2 | 5 | 4 | 3 | 6 | 1 | 8 | 2 | 6 | 6 | 5 | 8 | 7 | 4 | 3 | 5 | 5 | 4 | 4 | 6 | 7 | 5 | 4 | 4 | 4 | 4 | 4 |
| topazh.spc Topaz Harris_Par | 1 | 3 | 4 | 2 | 6 | 3 | 4 | 2 | 5 | 4 | 3 | 7 | 2 | 7 | 2 | 6 | 5 | 5 | 7 | 6 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 8 | 5 | 3 | 4 | 4 | 5 | 5 |
| topazi.spc Topaz HS184.3B~ | 2 | 2 | 2 | 2 | 4 | 4 | 3 | 4 | 7 | 3 | 1 | 7 | 1 | 9 | 1 | 8 | 7 | 6 | 9 | 8 | 7 | 6 | 8 | 7 | 2 | 3 | 2 | 7 | 6 | 3 | 3 | 3 | 2 | 2 |
| tourmali.spc Tourmaline HS2 | 5 | 8 | 7 | 7 | 0 | 5 | 2 | 8 | 6 | 5 | 3 | 5 | 3 | 6 | 1 | 3 | 7 | 1 | 1 | 9 | 4 | 7 | 7 | 2 | 1 | 8 | 3 | 4 | 5 | 6 | 6 | 6 | 6 | 6 |
| tremoli1.spc Tremolite HS18. | 4 | 5 | 5 | 4 | 8 | 5 | 8 | 5 | 2 | 5 | 1 | 5 | 2 | 7 | 4 | 8 | 1 | 9 | 4 | 2 | 9 | 1 | 0 | 0 | 9 | 1 | 9 | 5 | 7 | 4 | 3 | 4 | 2 | 3 |
| tremoli2.spc Tremolite NMNH | 3 | 4 | 5 | 4 | 3 | 7 | 6 | 7 | 2 | 6 | 5 | 3 | 5 | 7 | 2 | 6 | 3 | 7 | 5 | 4 | 8 | 4 | 3 | 1 | 8 | 3 | 9 | 5 | 3 | 7 | 7 | 7 | 7 | 7 |
| trona.spc Trona GDS148~~2 | 1 | 3 | 3 | 2 | 6 | 3 | 5 | 3 | 9 | 0 | 0 | 9 | 0 | 3 | 0 | 0 | 1 | 6 | 3 | 2 | 5 | 6 | 6 | 8 | 1 | 1 | 3 | 8 | 8 | 0 | 0 | 0 | 0 | 0 |
| ulexite1.spc Ulexite HS441.3 | 2 | 1 | 2 | 1 | 6 | 2 | 8 | 2 | 9 | 0 | 0 | 8 | 3 | 6 | 9 | 9 | 8 | 0 | 9 | 9 | 0 | 4 | 6 | 9 | 0 | 0 | 1 | 9 | 8 | 0 | 0 | 0 | 0 | 0 |
| ulexite2.spc Ulexite GDS138 | 1 | 1 | 1 | 1 | 7 | 2 | 8 | 2 | 9 | 0 | 0 | 9 | 4 | 7 | 9 | 9 | 7 | 0 | 9 | 8 | 0 | 3 | 7 | 9 | 0 | 0 | 3 | 9 | 9 | 0 | 0 | 0 | 0 | 0 |
| uralite.spc Uralite HS345.3B- | 7 | 1 | 0 | 2 | 8 | 0 | 8 | 4 | 1 | 8 | 7 | 1 | 7 | 4 | 6 | 6 | 2 | 8 | 4 | 5 | 9 | 6 | 5 | 1 | 9 | 4 | 9 | 5 | 4 | 8 | 8 | 8 | 9 | 8 |
| uvarovit.spc Uvarovite NMNH1 | 6 | 0 | 0 | 8 | 0 | 9 | 3 | 9 | 8 | 3 | 1 | 8 | 0 | 6 | 2 | 5 | 3 | 5 | 3 | 3 | 5 | 4 | 2 | 2 | 7 | 6 | 8 | 2 | 6 | 2 | 2 | 2 | 3 | 4 |
| vermicu1.spc Vermiculite GD | 3 | 4 | 4 | 3 | 7 | 4 | 6 | 2 | 8 | 0 | 2 | 9 | 4 | 0 | 8 | 0 | 0 | 9 | 4 | 1 | 8 | 9 | 8 | 6 | 7 | 2 | 7 | 7 | 8 | 0 | 0 | 0 | 1 | 1 |
| vermicu2.spc Vermiculite VT | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 4 | 8 | 0 | 2 | 7 | 4 | 1 | 8 | 0 | 0 | 8 | 7 | 5 | 8 | 9 | 8 | 7 | 6 | 2 | 5 | 7 | 7 | 1 | 1 | 1 | 1 | 1 |
| vermicu3.spc Vermiculite VT | 4 | 5 | 5 | 5 | 4 | 6 | 7 | 5 | 9 | 0 | 6 | 8 | 7 | 0 | 8 | 0 | 0 | 9 | 7 | 3 | 9 | 9 | 9 | 6 | 8 | 2 | 4 | 6 | 8 | 0 | 0 | 0 | 0 | 0 |
| vermicu4.spc Vermiculite WS | 5 | 4 | 4 | 4 | 2 | 3 | 2 | 7 | 5 | 5 | 5 | 3 | 5 | 2 | 7 | 3 | 1 | 8 | 3 | 2 | 7 | 7 | 7 | 2 | 8 | 7 | 7 | 4 | 3 | 6 | 6 | 5 | 5 | 4 |
| vesuvian.spc Vesuvianite HS4 | 9 | 7 | 7 | 9 | 6 | 6 | 2 | 6 | 3 | 5 | 1 | 8 | 1 | 8 | 4 | 7 | 8 | 5 | 0 | 1 | 4 | 8 | 8 | 7 | 0 | 5 | 0 | 0 | 3 | 5 | 2 | 2 | 1 | 1 |
| witherit.spc Witherite HS273. | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 6 | 3 | 2 | 6 | 2 | 4 | 0 | 1 | 6 | 7 | 3 | 8 | 7 | 8 | 8 | 7 | 1 | 1 | 1 | 6 | 5 | 3 | 3 | 3 | 4 | 3 |
| wollasto.spc Wollastonite HS | 1 | 2 | 2 | 2 | 6 | 3 | 5 | 3 | 7 | 2 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 3 | 5 | 5 | 3 | 2 | 3 | 4 | 5 | 6 | 4 | 8 | 7 | 3 | 5 | 5 | 6 | 6 |
| zincite.spc Zincite+Franklin H | 2 | 8 | 9 | 8 | 0 | 9 | 0 | 8 | 8 | 7 | 8 | 1 | 8 | 3 | 5 | 2 | 2 | 5 | 5 | 3 | 4 | 2 | 3 | 3 | 7 | 7 | 6 | 1 | 3 | 8 | 8 | 8 | 9 | 9 |
| zircon.spc Zircon WS522~~1 | 6 | 8 | 9 | 8 | 3 | 8 | 2 | 6 | 3 | 5 | 6 | 2 | 7 | 6 | 1 | 2 | 3 | 3 | 6 | 7 | 3 | 3 | 3 | 4 | 5 | 5 | 5 | 1 | 3 | 5 | 6 | 6 | 7 | 7 |
| zoisite.spc Zoisite HS347.3B | 0 | 9 | 9 | 8 | 1 | 0 | 0 | 0 | 1 | 7 | 0 | 0 | 0 | 3 | 5 | 4 | 4 | 8 | 2 | 2 | 9 | 8 | 7 | 3 | 4 | 8 | 1 | 1 | 0 | 1 | 2 | 4 | 3 | 3 |

# Appendix B

## Hyperion Selected 34 Ratio Code Ranges for 475 USGS Spectral Reflectance Library of Minerals and Vegetation

**The following tables give the top of each ratio code range, from 0 to 9. For instance, the range of the 0 ratio code of the R(20/5) Hyperion spectral ratio is from 0-1.032564 and the 9 ratio code of the same spectral ratio is any spectral ratio value >2.334565 (though the highest value in this spectral reflectance library is 20.90941 for that same spectral ratio).**

| R(20/5) | R(25/17) | R(26/20) | R(36/9) | R(36/55) | R(41/25) | R(43/83) | R(45/36) | R(89/105) | R(137/84) |
|---|---|---|---|---|---|---|---|---|---|
| 20.90941 | 6.732663 | 6.136089 | 20.55977 | 5.729784 | 3.272624 | 5.511264 | 1.636156 | 2.52271 | 5.969393 |
| 2.334565 | 1.442741 | 1.298412 | 2.758138 | 1.197574 | 1.371023 | 1.252682 | 1.144527 | 1.052848 | 2.220014 |
| 1.764411 | 1.243581 | 1.1615 | 1.916433 | 1.036401 | 1.175878 | 1.074095 | 1.094305 | 1.010527 | 1.656611 |
| 1.57535 | 1.14596 | 1.080942 | 1.559256 | 1.009431 | 1.111146 | 1.038235 | 1.048635 | 0.99884 | 1.350668 |
| 1.428771 | 1.088865 | 1.051867 | 1.372443 | 0.997267 | 1.071343 | 1.014887 | 1.026172 | 0.991824 | 1.138677 |
| 1.341447 | 1.062279 | 1.035063 | 1.262796 | 0.984738 | 1.04801 | 1.005141 | 1.016549 | 0.98152 | 1.056568 |
| 1.241684 | 1.039358 | 1.023252 | 1.186298 | 0.974945 | 1.03124 | 0.995278 | 1.010536 | 0.953564 | 1.014613 |
| 1.161066 | 1.024509 | 1.011752 | 1.120558 | 0.957099 | 1.016077 | 0.981447 | 1.002106 | 0.915123 | 0.986252 |
| 1.095034 | 1.011956 | 0.997019 | 1.071801 | 0.911545 | 1.000523 | 0.951893 | 0.987889 | 0.854759 | 0.934852 |
| 1.032564 | 0.962875 | 0.952071 | 1.027939 | 0.85327 | 0.894775 | 0.896645 | 0.913985 | 0.75949 | 0.747383 |
| Top of Ranges of Ratio Codes | | | | | | | | | |

| R(148/141) | R(151/160) | R(152/136) | R(185/198) | R(188/185) | R(190/196) | R(196/202) | R(205/216) | R(207/202) | R(207/205) |
|---|---|---|---|---|---|---|---|---|---|
| 1.471335 | 1.690754 | 2.087114 | 3.046576 | 2.584538 | 2.223246 | 2.659171 | 6.601644 | 1.604518 | 1.946924 |
| 1.097165 | 1.058863 | 1.246915 | 1.124908 | 1.126682 | 1.089962 | 1.231764 | 1.524037 | 1.092224 | 1.127469 |
| 1.049232 | 1.029195 | 1.132397 | 1.052417 | 1.069606 | 1.035929 | 1.085118 | 1.283181 | 1.026747 | 1.039103 |
| 1.028941 | 1.013321 | 1.078185 | 1.012134 | 1.041634 | 1.018382 | 1.040583 | 1.118134 | 1.006445 | 1.014809 |
| 1.019795 | 1.004938 | 1.053198 | 0.988396 | 1.02594 | 1.00694 | 1.026108 | 1.03845 | 0.997371 | 1.0055 |
| 1.009829 | 0.99927 | 1.034718 | 0.975109 | 1.015513 | 0.99561 | 1.01355 | 1.008531 | 0.989721 | 1.000845 |
| 1.003727 | 0.993533 | 1.017598 | 0.96315 | 1.010514 | 0.989197 | 1.005586 | 0.99548 | 0.976282 | 0.994767 |
| 1.000113 | 0.9839 | 1.006869 | 0.934909 | 1.004607 | 0.980208 | 0.99815 | 0.978805 | 0.958392 | 0.985165 |
| 0.994868 | 0.968658 | 0.99853 | 0.878538 | 0.997596 | 0.961886 | 0.98627 | 0.943334 | 0.925594 | 0.973238 |
| 0.971872 | 0.925682 | 0.957755 | 0.78028 | 0.980915 | 0.929907 | 0.951288 | 0.831587 | 0.863558 | 0.937145 |

| R(208/215) | R(211/218) | R(213/218) | R(216/225) | R(221/216) | R(224/218) | R(218/216) | R(5/105) | R(41/105) | R(148/105) |
|---|---|---|---|---|---|---|---|---|---|
| 3.984923 | 3.061767 | 2.848755 | 2.780741 | 3.877876 | 4.018942 | 4.222282 | 5.63494 | 12.11861 | 6.877454 |
| 1.348952 | 1.29318 | 1.23119 | 1.321246 | 1.161285 | 1.125579 | 1.093575 | 0.991025 | 1.20343 | 1.85371 |
| 1.220681 | 1.198064 | 1.165752 | 1.190908 | 1.048935 | 1.032324 | 1.022963 | 0.887979 | 1.059941 | 1.379351 |
| 1.110991 | 1.148866 | 1.110175 | 1.112888 | 1.015154 | 1.00821 | 1.00686 | 0.814146 | 1.007027 | 1.171855 |
| 1.052925 | 1.087541 | 1.075517 | 1.062881 | 1.002305 | 0.997317 | 1.000172 | 0.738668 | 0.987842 | 1.072714 |
| 1.026041 | 1.051818 | 1.047047 | 1.022833 | 0.989669 | 0.981216 | 0.992741 | 0.657782 | 0.970498 | 1.028391 |
| 1.0073 | 1.01776 | 1.015617 | 1.000782 | 0.969147 | 0.96764 | 0.982196 | 0.57953 | 0.931309 | 1.008212 |
| 0.997344 | 1.000739 | 0.998779 | 0.980288 | 0.938846 | 0.92295 | 0.970309 | 0.493881 | 0.877615 | 0.989335 |
| 0.983924 | 0.988468 | 0.983623 | 0.941187 | 0.901244 | 0.866311 | 0.946046 | 0.372369 | 0.807408 | 0.940199 |
| 0.94711 | 0.954224 | 0.94728 | 0.825062 | 0.841948 | 0.787796 | 0.908284 | 0.203691 | 0.69756 | 0.776544 |

| R(169/105) | R(188/105) | R(211/105) | R(225/105) |
|---|---|---|---|
| 9.901186 | 10.5352 | 10.67225 | 10.48524 |
| 2.040706 | 2.089092 | 1.823316 | 1.809093 |
| 1.387214 | 1.381247 | 1.27198 | 1.201893 |
| 1.189833 | 1.170956 | 1.068387 | 1.051624 |
| 1.069446 | 1.049696 | 1.005041 | 0.96884 |
| 1.025107 | 0.998201 | 0.933866 | 0.880593 |
| 0.996042 | 0.952006 | 0.847453 | 0.763054 |
| 0.949752 | 0.868437 | 0.752178 | 0.620658 |
| 0.873094 | 0.75712 | 0.643101 | 0.467894 |
| 0.730728 | 0.515457 | 0.494892 | 0.330813 |