KAGUYA (SELENE)

# Product Format Description

## - Gamma Ray Spectrometer (GRS)-

Version 1.0

November 1, 2009

# INDEX

# 1. Introduction

## 1.1 Purpose

This document describes the format*2 used for the catalog and product files for the Gamma Ray Spectrometer*1(GRS) that was board KAGUYA (SELENE). These files provided by Japan Aerospace Exploration Agency (JAXA).

*1 : Refer to the following "Project Homepage of KAGUYA" and "Image Gallery of KAGUYA" used for the GRS mission.

- ✓ Project Homepage for KAGUYA
  http://www.kaguya.jaxa.jp/en/equipment/grs_e.htm

- ✓ Image Gallery for KAGUYA
  http://wms.selene.darts.isas.jaxa.jp/selene_viewer/en/observation_mission/grs/

*2 : The data format used for SELENE is based on the PDS (Planetary Data System) by NASA. However, the data format is not fully compliant with the PDS format.

## 1.2 The composition of this format description

Table 1-1 shows the composition of this format description.

**Table 1-1 the composition of this format description**

| No. | INDEX | Title | Description content |
|---|---|---|---|
| 1 | Section 1.3 | Table 1-2 GRS Products List | The name of the product, the object form, and the composition of the product are described as a product list illustrated by this description. |
| | | Table 1-3 Product Description | Concerning each product shown in the No1 product list, the content included in data and the description of the observation method are illustrated. |
| 2 | Chapter X | " Product Name" | Concerning the product shown in the No1 product list, rules used for file naming, label format, data object format and catalog information file format are described. |
| 3 | Section X.1 | Rules used for File naming | Concerning the product shown in No2, the rules of file nomenclature is described. |
| 4 | Section X.2 | Label Format | Concerning the product shown in No2, the label format is described. |
| 5 | Section X.3 | Data Object Format | Concerning the product shown in No2, the data format of the data object is described. (The extension of the data file is unique in each product. Therefore, refer to the file nomenclature in No3. ) |
| 6 | Section X.4 | Catalog Information File Format | Concerning the product shown in No2, the format of the catalog information file (extension: .ctg ) of the product is described. |
| 7 | Chapter X+1 | | |
| | | Same as above | |

## 1.3 Data Set

The Data Set refers to a set consisting of: Product, Catalog Information, and Thumbnail Image (JPEG format), which are tar-archived. This set is referred to as the "L2 Data Set". The file extension is "SL2". However, the thumbnail image may be omitted at the by composer's judgment.

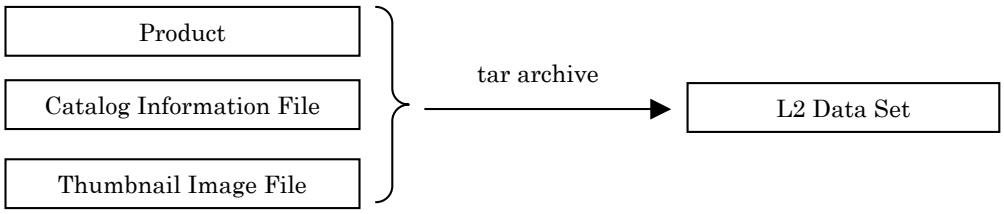


**Figure 1-1 composition of the L2 Data Set**

### 1.3.1 Product

For product composition, two possible options are available. Product Composition – Attached consists of label information and data information in a single data file. Product Composition – detached consists of separate files for the label file and data file.

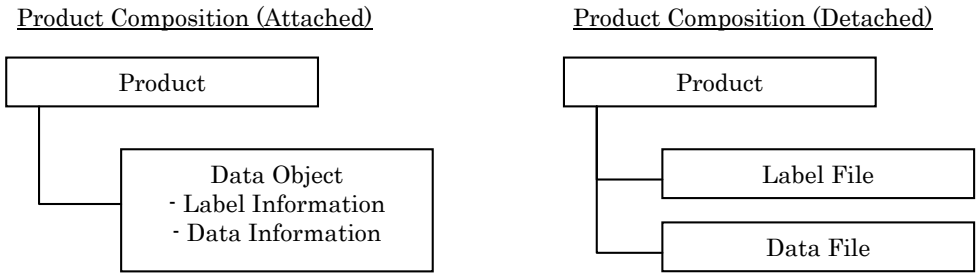


**Figure 1-2 Product Composition : Attached and Detached**

(1) Label File (Data Object (Label Information)

The Label File (Label Information) is storing as text format the information that identifies the Data File (Data Information).

(2) Data File (Data Object (Data Information))

The data File (Data Object (Data Information)) of the product are classified into the following four data types.

a) IMAGE : image data
An IMAGE is a two-dimensional array of values, all of the same type, each of which is referred to as a sample. IMAGE are normally processed with special display tools to produce a visual representation of the samples by assigning brightness levels or display colors to the values. An IMAGE consists of a series of lines, each containing the same number of samples.
*Refer to the PDS Standard Reference V3.8 Appendix A.20 "IMAGE".

b) TABLE : tabular form data
TABLEs are a natural storage format for collections of data from many instruments. The TABLE is a uniform collection of rows containing ASCII or binary values stored in columns.
*Refer to the PDS Standard Reference V3.8 Appendix A.29 "TABLE".

c) SERIES : time series data
The SERIES is a sub-class of the TABLE. It is used for storing a sequence of measurements organized in a specific way. The sampling parameter keywords in the SERIES represent the variation between the ROWS of data.
*Refer to the PDS Standard Reference V3.8 Appendix A.24 "SERIES"

d) TEXT : text data
The TEXT describes a file which contains plain text.
*Refer to the PDS Standard Reference V3.8 Appendix A.30 "TEXT".

### 1.3.2 Catalog Information File

Catalog Information File is the information file attached to explain the general of the product and is used to search for the product from L2DB subsystem.

### 1.3.3 Thumbnail Image File

Thumbnail Image File is the reduced image of the data object, and is the JPEG format image. However, the thumbnail image may be omitted at the by composer's judgment.

## 1.4 GRS Products

The list of GRS products, which this document describes, is shown in Table 1-2. In addition, the description for each product is shown in Table 1-3.

**Table 1-2 GRS Products List**

| Level*1 | Product Name | Product ID | Data Type | Product Format *2 |
|---|---|---|---|---|
| Standard | Gamma Ray Energy Spectrum 2 | GRS_EnergySpectrum_2 | TABLE | A |
| Standard | Gamma Ray Intensity Map A (K, Th, O, Fe, Si) | GRS_GammaRayMap_A_K | IMAGE | A |
| | | GRS_GammaRayMap_A_Th | IMAGE | A |
| | | GRS_GammaRayMap_A_O | IMAGE | A |
| | | GRS_GammaRayMap_A_Fe | IMAGE | A |
| | | GRS_GammaRayMap_A_Si | IMAGE | A |
| | Gamma Ray Intensity Map B (U, Al, Ca, Mg, Ti) | GRS_GammaRayMap_B_U | IMAGE | A |
| | | GRS_GammaRayMap_B_Al | IMAGE | A |
| | | GRS_GammaRayMap_B_Ca | IMAGE | A |
| | | GRS_GammaRayMap_B_Mg | IMAGE | A |
| | | GRS_GammaRayMap_B_Ti | IMAGE | A |
| Higher Level | Nuclide Map A (K, Th, O, Fe, Si) | GRS_NuclideMap_A_K | IMAGE | A |
| | | GRS_NuclideMap_A_Th | IMAGE | A |
| | | GRS_NuclideMap_A_O | IMAGE | A |
| | | GRS_NuclideMap_A_Fe | IMAGE | A |
| | | GRS_NuclideMap_A_Si | IMAGE | A |
| | Nuclide Map B (U, Al, Ca, Mg, Ti) | GRS_NuclideMap_B_U | IMAGE | A |
| | | GRS_NuclideMap_B_Al | IMAGE | A |
| | | GRS_NuclideMap_B_Ca | IMAGE | A |
| | | GRS_NuclideMap_B_Mg | IMAGE | A |
| | | GRS_NuclideMap_B_Ti | IMAGE | A |

: Map product

*1 Data obtained by equipments is not clear as it is, therefore various processings and correction treatment are necessary by the ground system. According to the difference in the process of processing and correction treatment, they can be classified to the standard processing and higher-level processing. The higher-level processing refers to the standard processing data to which various processing and correction treatment are conducted according to the research purpose et cetra.

*2 Product Format : A - Attached, D - Detached

## Table 1-3 Product Description

| Product Name | Product ID |
|---|---|
| Gamma Ray Energy Spectrum 2 | Energy spectra of gamma rays obtained by GRS for the energy ranges of from 0.2 to 12 MeV (low gain spectrum) and from 0.2 to 3 MeV (high gain spectrum). The spectra are accumulated in the regions with about 900 km × 900 km for 1 month. This product is corrected for the energy calibration and the observation time of GRS. |
| Gamma Ray Intensity Map (K) | Count rate map of gamma rays from potassium observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (Th) | Count rate map of gamma rays from a nuclide in thorium series observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (O) | Count rate map of gamma rays from oxygen observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (Fe) | Count rate map of gamma rays from iron observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line of in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (Si) | Count rate map of gamma rays from silicon observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (U) | Count rate map of gamma rays from a nuclide in uranium series observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (Al) | Count rate map of gamma rays from aluminum observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |

| | |
|---|---|
| Gamma Ray Intensity Map (Ca) | Count rate map of gamma rays from calcium observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (Mg) | Count rate map of gamma rays from magnesium observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Gamma Ray Intensity Map (Ti) | Count rate map of gamma rays from titanium observed over 100 km altitude. The count rates are derived by fitting the gamma-ray line in spectra accumulated in cells that cover the entire Moon. In this procedure, the net counts are not corrected for backgrounds from the spacecraft or the GRS instrument. The gamma-ray intensity may not be obtained with high precision in the beginning of the mission since the sufficient accumulation time is necessary. The data set is preliminary processed by possible methods available by the time of distribution, and is subject for update in the future. |
| Nuclide Map (K) | Elemental distribution map in mass fraction of potassium in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (Th) | Elemental distribution map in mass fraction of thorium in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (O) | Elemental distribution map in mass fraction of oxygen in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (Fe) | Elemental distribution map in mass fraction of iron in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (Si) | Elemental distribution map in mass fraction of silicon in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (U) | Elemental distribution map in mass fraction of uranium in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (Al) | Elemental distribution map in mass fraction of aluminum in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (Ca) | Elemental distribution map in mass fraction of calcium in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (Mg) | Elemental distribution map in mass fraction of magnesium in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |
| Nuclide Map (Ti) | Elemental distribution map in mass fraction of titanium in the sub-surface of the Moon measured by GRS. The data set is preliminary processed by possible methods available by the time of distribution, and is subject to update in the future. |

:Map product

## 2. Gamma Ray Energy Spectrum

### 2.1 Rules used for File naming

The nomenclature used for Label, Data Object and Catalog Information File the GRS products are described below. In addition, the file names are case-independent.

GRS_ESPEC2_*YYMMDD_YYMMDD.ext* : Gamma Ray Energy Spectrum 2

- *YYMMDD_YYMMDD* : "Start Date _ End Date" of observation (6 characters each)
- *ext* : File Extension
  - ✓ tbl : Product
  - ✓ ctg : Catalog Information File
  - ✓ sl2 : L2 Data Set (tar archive)

***<Example of Name : Gamma Ray Energy Spectrum 2>***

GRS_ESPEC2_071214_080218.tbl (Product File)

## 2.2 Label Format

The Label format for the TABLE object used for the Gamma Ray Energy Spectrum 2 is shown in Table 2-1. The Label of TABLE object includes: Standard Item.

In Table 2-1, the numerical values and the character strings that correspond to the type of the product, etc. is set, with the exception of those values shown as “STATIC”.

**Table 2-1 Label Format**

| No. | Items | Elements | Types | Values |
|---|---|---|---|---|
| **Standard Item** | | | | |
| 1 | PDS version number | PDS_VERSION_ID = %s | char | PDS3 [STATIC] |
| 2 | Record format of the file | RECORD_TYPE = %s | char | UNDEFINED [STATIC] |
| 3 | File name | FILE_NAME = %s | char | See Section 2.1 “Rules used for File naming”. |
| 4 | Name of the mission | MISSION_NAME = %s | char | SELENE [STATIC] |
| 5 | Name of the spacecraft | SPACECRAFT_NAME = %s | char | SELENE-M[STATIC] |
| 6 | Name of the instrument (Full name) | INSTRUMENT_NAME = %s | char | GRS [STATIC] |
| 7 | Product name | PRODUCT_SET_ID = %s | char | See Table 1-2 “Product_ID”. |
| 8 | Version number of the product | PRODUCT_VERSION_ID = %s | char | X.X |
| 9 | Target name | TARGET_NAME = %s | char | MOON [STATIC] |
| 10 | Comment | COMMENT_TEXT = "%s" | char | X |
| 11 | Starting position of the table object | ^TABLE = %d <BYTES> | int | XXX <BYTES> |
| **END Statements** | | | | |
| | | END | | |

***<Example of Label : Gamma Ray Energy Spectrum 2>***

```
FILE_NAME                = GRS_ESPEC2_071214_080218.tbl
INSTRUMENT_NAME            = GRS
PRODUCT_SET_ID           = GRS_EnergySpectrum_2
PRODUCT_VERSION_ID         = 1.0
PDS_VERSION_ID           = PDS3
RECORD_TYPE              = UNDEFINED
MISSION_NAME             = SELENE
SPACECRAFT_NAME            = SELENE-M
TARGET_NAME              = MOON
COMMENT_TEXT               = "Energy Spectrum"
^TABLE                   = 414 <BYTES>
END
```

## 2.3 Data Object Format

The data format for the Gamma Ray Energy Spectrum 2 products includes multiple pixel spectrum data. One pixel data consists of one ROW. Each ROW consists of 6 COLUMNs. Additionally, each COLUMN includes multiple ITEMs, as shown in Table 2-2. (All float elements are 4 bytes. One ROW is fixed at a length of 65596 bytes.)

**Table 2-2 Contents of one ROW**

| COLUMN | Data | Description | Size |
|---|---|---|---|
| 1 | Pixel coordinate | The pixel coordinates are expressed by the 8 ITEMs, which are the northwestern-most, northeastern-most, southwestern-most, and the southeastern-most, latitude and longitude coordinates. | float×8 |
| 2 | Observation time | Observation time is expressed in seconds | float×1 |
| 3 | high-gain conversion coefficient for data | The coefficient of conversion equation is shown by 3 ITEMs in the order of $0^{th}$, $1^{st}$, $2^{nd}$. | float×3 |
| 4 | high-gain data | Spectrum count data is entered sequentially from 0ch to 8191ch (8192 ITEMs). | float×8192 |
| 5 | low-gain conversion coefficient for data | Same as COLUMN 3. | float×3 |
| 6 | low-gain data | Same as COLUMN 4. | float×8192 |

The byte position of each data part is shown in Figure 2-1 Data unit format

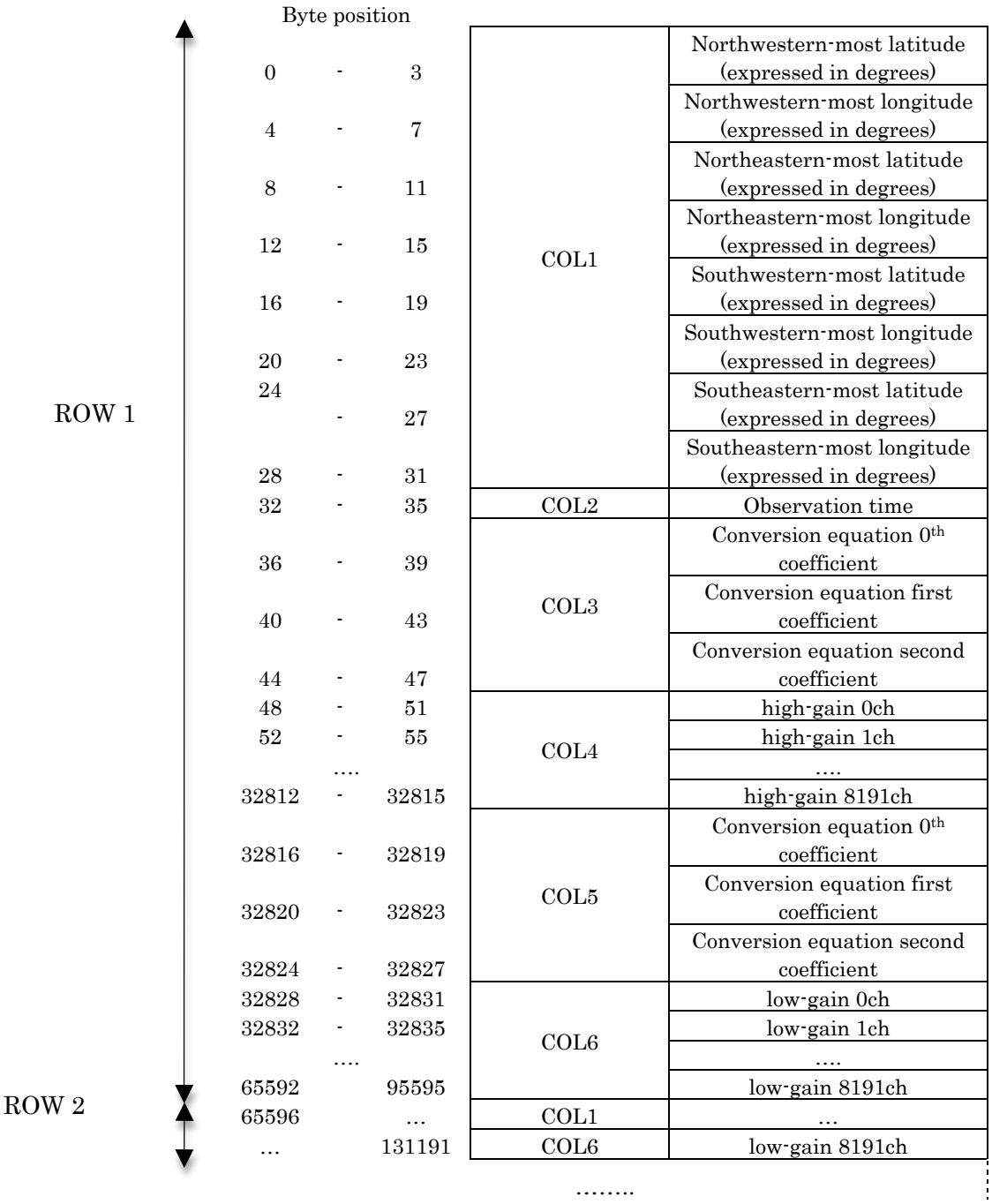


**Figure 2-1 Data unit format**

## 2.4 Catalog Information File Format

The Catalog Information File Format is shown in Table 2-3.

**Table 2-3 Catalog Information File Format**

| Item Name | Elements | Format of Value | Range of Value | Values |
|---|---|---|---|---|
| Name of the data file (*1) | DataFileName | AAAA….AAAA ( Up to 31 digits ) | alphanumeric characters | dependent on the product (See Section 2.1 "Rules used for File naming".) |
| Size of the data file | DataFileSize | NNNNNNNNNNNN ( Up to 12 digits ) | unit:<byte> | dependent on the product |
| File format of the data file | DataFileFormat | AAAA….AAAA ( Up to 16 digits ) | character strings | PDS [STATIC] |
| Name of the instrument | InstrumentName | AAAA….AAAA ( Up to 16 digits ) | character strings | GRS [STATIC] |
| Processing level | ProcessingLevel | AAAA….AAAA ( Up to 16 digits ) | character strings | dependent on the product (See Table 1-2 "Level".) |
| Product ID | ProductID | AAAA….AAAA ( Up to 30 digits ) | character strings | dependent on the product (See Table 1-2 "Product_ID".) |
| Version number of the product | ProductVersion | AAAA….AAAA ( Up to 16 digits ) | character strings | dependent on the product |
| Access level | AccessLevel | N | values of 0-4 | N/A |
| Start time | StartDateTime | yyyy- mmddT hh: mm: ss.ssssssZ | DATE & TIME | dependent on the product |
| Stop time | EndDateTime | yyyy- mmddT hh: mm: ss.ssssssZ | DATE & TIME | dependent on the product |
| Upper left latitude of the scene | UpperLeftLatitude | SNN.NNNNNN | -90-90 | 90.0[STATIC] |
| Upper left longitude of the scene | UpperLeftLongitude | NNN.NNNNNN | 0-360 | 0.0[STATIC] |
| Upper right latitude of the scene | UpperRightLatitude | SNN.NNNNNN | -90-90 | 90.0[STATIC] |
| Upper right longitude of the scene | UpperRightLongitude | NNN.NNNNNN | 0-360 | 360.0[STATIC] |
| Lower left latitude of the scene | LowerLeftLatitude | SNN.NNNNNN | -90-90 | -90.0[STATIC] |
| Lower left longitude of the scene | LowerLeftLongitude | NNN.NNNNNN | 0-360 | 360.0[STATIC] |
| Lower right latitude of the scene | LowerRightLatitude | SNN.NNNNNN | -90-90 | -90.0[STATIC] |
| Lower right longitude of the scene | LowerRightLongitude | NNN.NNNNNN | 0-360 | 360.0[STATIC] |

(*1) "DataFileName" is the stored file name of the product. For the detached format, this is the stored file name.

***<Example of Catalog Information: Gamma Ray Energy Spectrum 2>***

```
DataFileName                = GRS_ESPEC2_071214_080218.tbl
DataFileFormat              = PDS
#
InstrumentName              = GRS
ProcessingLevel             = standard
ProductID           = GRS_EnergySpectrum_2
ProductVersion              = 1.0
AccessLevel         = 3
StartDateTime               = 2007-12-14T00:00:00.000000Z
EndDateTime         = 2008-02-18T00:00:00.000000Z
#
UpperLeftLatitude   = 90.0
```

UpperLeftLongitude = 0.0
UpperRightLatitude = 90.0
UpperRightLongitude = 360.0
LowerLeftLatitude = -90.0
LowerLeftLongitude = 0.0
LowerRightLatitude = -90.0
LowerRightLongitude = 360.0
#
DataFileSize = 3149022

## 3. Gamma Ray Intensity Map, Nuclide Map

### 3.1 Rules used for File naming

GRS_IMAP_*MM*_*YYMMDD*_*yymmdd.ext* : Gamma Ray Intensity Map
GRS_IMAP_*MM*_H_*YYMMDD*_*yymmdd.ext* : Gamma Ray Intensity Map (In the case of High-resolution)
GRS_NMAP_*MM*_*YYMMDD*_*yymmdd.ext* : Nuclide Map
GRS_NMAP_*MM*_H_*YYMMDD*_*yymmdd.ext* : Nuclide Map (In the case of High-resolution)

- *MM* : Elemental type
  - ✓ K, Th, O, Fe, Si, U, Al, Ca, Mg, Ti
- *YYMMDD* : Start date of observation
- *yymmdd* : End date of observation
- *ext* : File Extension
  - ✓ img : Product
  - ✓ ctg : Catalog Information File
  - ✓ jpg : Thumbnail JPEG Image File
  - ✓ sl2 : L2 Data Set (tar archive)

***<Example of Name : Gamma Ray Intensity Map (K)>***
GRS_IMAP_K_071212_080217.img (Product File)

## 3.2 Label Format

The Label format for the IMAGE object used for the Gamma Ray Intensity Map and Nuclide Map is shown in

Table 3-1. The Label for the IMAGE object includes: Standard Item, Image Data Object Format Description Part and IMAGE_MAP_PROJECTION Object Description Part.

In

Table 3-1 with the exception of the Values expressed as “STATIC”, the numerical values and the character strings corresponding to the type of the product etc., are set.

**Table 3-1 Label Format**

| No | Items | Elements | Types | Values |
|---|---|---|---|---|
| **Standard Item (/* BASIC */)** | | | | |
| 1 | PDS version number | PDS_VERSION_ID = %s | char | PDS3 [STATIC] |
| 2 | Record format of the file | RECORD_TYPE = %s | char | UNDEFINED [STATIC] |
| 3 | File name | FILE_NAME = %s | char | See Section 3.1 “Rules used for File naming”. |
| 4 | Name of the mission | MISSION_NAME = %s | char | SELENE [STATIC] |
| 5 | Name of the spacecraft | SPACECRAFT_NAME = %s | char | SELENE-M[STATIC] |
| 6 | Name of the instrument | INSTRUMENT_NAME = %s | char | GRS [STATIC] |
| 7 | Product name | PRODUCT_SET_ID = %s | char | See Table 1-2 “Product_ID”. |
| 8 | Version number of the product | PRODUCT_VERSION_ID = %s | char | X.X |
| 9 | Target name | TARGET_NAME = %s | char | MOON [STATIC] |
| 10 | Comment | COMMENT_TEXT = "%s" | char | X |
| 11 | Starting position of the image object | ^IMAGE = %d <BYTES> | int | XXXX <BYTES> |
| **Image Data Object Format Description Part(/* IMAGE */)** | | | | |
| | | OBJECT = IMAGE | | |
| 11 | Band storage type | BAND_STORAGE_TYPE = %s | char | BAND_SEQUENTIAL [STATIC] *Refer to the PDS Standard Reference V3.5 Appendix A.19 “IMAGE”. |
| 12 | Number of bands | BANDS = %d | smallint | 1[STATIC] |
| 13 | Maximum of the data | DERIVED_MAXIMUM = %f | float | XXX |
| 14 | Minimum of the data | DERIVED_MINIMUM = %f | float | XXX |
| 15 | Compression class and encoding type | ENCODING_TYPE = %s | char | N/A [STATIC] |
| 16 | Alternative value outside assumption | INVALID_CONSTANT = %s | char | X |
| 17 | Horizontal pixel count of image | LINE_SAMPLES = %d | int | XX |
| 18 | Vertical pixel count of image | LINES = %d | int | XX |
| 19 | Alternative value of missing value | MISSING_CONSTANT = %s | char | X(may be omitted) |
| 20 | Offset | OFFSET = %f | float | X.X |
| 21 | Significant bit mask | SAMPLE_BIT_MASK = %s | char | 1111111111111111[STATIC] |
| 22 | Pixel bit length | SAMPLE_BITS = %d | int | 16[STATIC] |
| 23 | Pixel type | SAMPLE_TYPE = %s | char | MSB_INTEGER MSB_UNSIGNED_INTEGER * Refer to the PDS Standard Reference V3.5 Appendix C.1 and C.2 for further |

| | | | | |
|---|---|---|---|---|
| | | | | information. |
| 24 | Scaling factor | SCALING_FACTOR = %f | float | X.X |
| 25 | Stretched Flag | STRETCHED_FLAG = %s | char | FALS E[STATIC] |
| | | END_OBJECT = IMAGE | | |
| **IMAGE_MAP_PROJECTION Object Description Part(/* IMAGE_MAP_PROJECTION */)** | | | | |
| | | OBJECT = IMAGE_MAP_PROJECTION | | |
| 26 | Semi-major axis of the ellipsoidal body | A_AXIS_RADIUS = %f<KM> | float | 1737.400 <km> [STATIC] |
| 27 | medial axis of ellipsoidal body | B_AXIS_RADIUS = %f<KM> | float | 1737.400 <km> [STATIC] |
| 28 | Semi-minor axis of ellipsoidal body | C_AXIS_RADIUS = %f<KM> | float | 1737.400 <km> [STATIC] |
| 29 | Name of coordinate system | COORDINATE_SYSTEM_NAME = "%s" | char | "PLANETOCENTRIC "[STATIC] |
| 30 | Type of coordinate system | COORDINATE_SYSTEM_TYPE = "%s" | char | "BODY-FIXED ROTATING" [STATIC] |
| 31 | Easternmost longitude | EASTERNMOST_LONGITUDE = %f | float | 360.0 [STATIC] |
| 32 | Westernmost longitude | WESTERNMOST_LONGITUDE = %f | float | 0.0 [STATIC] |
| 33 | Maximum latitude | MAXIMUM_LATITUDE = %f | float | 90.0 [STATIC] |
| 34 | Minimum latitude | MINIMUM_LATITUDE = %f | float | -90.0 [STATIC] |
| 35 | Map projection type | MAP_PROJECTION_TYPE = "%s" | char | SIMPLE_CYLINDRICAL [STATIC] |
| 36 | Resolution | MAP_RESOLUTION = %f<PIXEL/DEGREE> | float | X |
| 37 | Direction of positive longitude | POSITIVE_LONGITUDE_DIRECTION = "%s" | char | EAST [STATIC] |
| | | END_OBJECT = IMAGE_MAP_PROJECTION | | |
| **END statement** | | | | |
| | | END | | |

### *<Example of Label : Gamma Ray Intensity Map A (K)>*

```
FILE_NAME = GRS_IMAP_K_071212_080217.img
INSTRUMENT_NAME = GRS
PRODUCT_SET_ID = GRS_GammaRayMap_A_K
PRODUCT_VERSION_ID = 1.0
PDS_VERSION_ID = PDS3
RECORD_TYPE = UNDEFINED
MISSION_NAME = SELENE
SPACECRAFT_NAME = SELENE-M
TARGET_NAME = MOON
COMMENT_TEXT = "this is a sample data, containing the intensity map of gamma rays emitted from Pottasium on lunar subsurface."
OBJECT = IMAGE_MAP_PROJECTION
  A_AXIS_RADIUS = 1737.400<KM>
  B_AXIS_RADIUS = 1737.400<KM>
  C_AXIS_RADIUS = 1737.400<KM>
  COORDINATE_SYSTEM_NAME = "PLANETOCENTRIC"
  COORDINATE_SYSTEM_TYPE = "BODY-FIXED ROTATING"
  EASTERNMOST_LONGITUDE = 360.0
  WESTERNMOST_LONGITUDE = 0.0
  MAXIMUM_LATITUDE = 90.0
  MINIMUM_LATITUDE = -90.0
  MAP_PROJECTION_TYPE = "SIMPLE CYLINDRICAL"
  MAP_RESOLUTION = 1<PIXEL/DEGREE>
  POSITIVE_LONGITUDE_DIRECTION = "EAST"
END_OBJECT = IMAGE_MAP_PROJECTION
OBJECT = IMAGE
  BAND_STORAGE_TYPE = BAND_SEQUENTIAL
  BANDS = 1
  ENCODING_TYPE = N/A
  INVALID_CONSTANT = 65535
```

```
  LINE_SAMPLES = 360
  LINES = 180
  MISSING_CONSTANT = 0
  OFFSET = 0.0
  SAMPLE_BIT_MASK = 1111111111111111
  SAMPLE_BITS = 16
  SAMPLE_TYPE = MSB_UNSIGNED_INTEGER
  STRETCHED_FLAG = FALSE
  DERIVED_MINIMUM = GRS_IMAP_K_071212_080217.img
  DERIVED_MAXIMUM = GRS_IMAP_K_071212_080217.img
  SCALING_FACTOR = GRS_IMAP_K_071212_080217.img
END_OBJECT = IMAGE
^IMAGE = 1391 <BYTES>
END
```

## 3.3 Data Object Format

The data objects of the Gamma Ray Intensity Map and Nuclide Map includes multiple pixel Gamma Ray Intensity or Elemental Concentration. The file format is composed of 180 Rows. One row consists of 360 COLUMNs of BAND_SEQUNTIAL. The number of ROWs are fixed at 180 lines. One COLUMN represents one pixel (1 latitude × 1 longitude) The 360 data elements encompasses the entire longitude directions (180 degree of longitude as defined as the center of near side of the moon and points from 0 to 360 degree) with certain latitudes that are included within each ROW. The first ROW corresponds to the 90 degree of latitude (North Pole). The 180th ROW corresponds to the -90 degree of latitude (South Pole) (See Figure 3-1). The numerical value included within COLUMN 1 is 1 ITEM and the unsigned short int type (2 byte integer). The physical unit of each map data is listed within the comment sections of the map product.

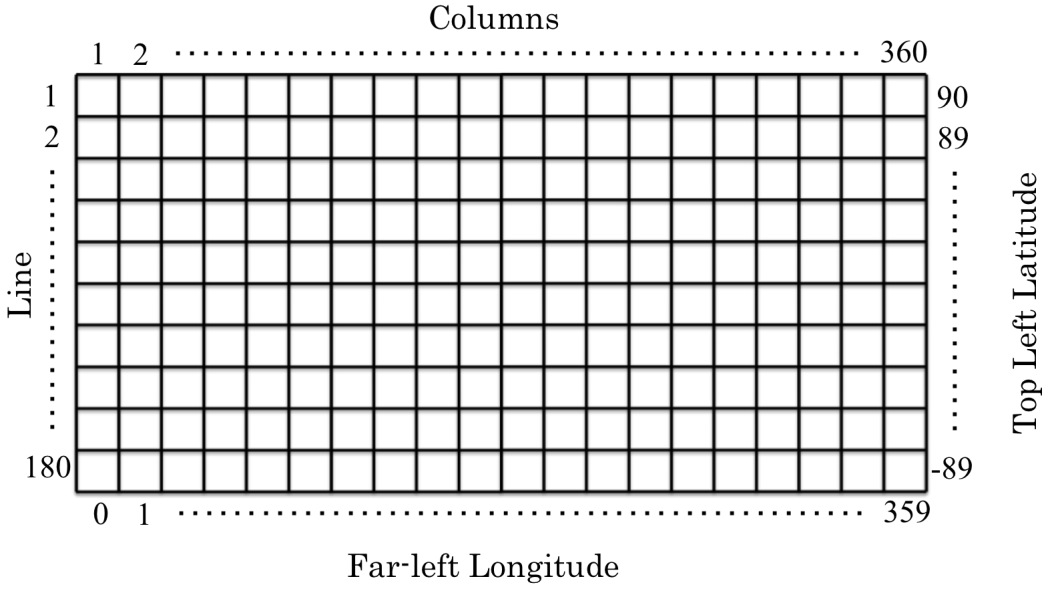


**Figure 3-1 ROWs of latitude data and COLUMNs of longitude data**

| | Byte position | | | COLUMN | Data Element | Data type |
|---|---|---|---|---|---|---|
| Line 1 | 0 | - | 1 | COL1 | gamma ray intensity or elemental concentration | unsigned short int×1 |
| | 2 | - | 3 | COL2 | gamma ray intensity or elemental concentration | unsigned short int×1 |
| | 4 | - | 5 | COL3 | gamma ray intensity or elemental concentration | unsigned short int×1 |
| | | | | …. | | |
| | 718 | - | 719 | COL360 | gamma ray intensity or elemental concentration | unsigned short int×1 |
| Line 2 | 720 | - | 721 | COL1 | gamma ray intensity or elemental concentration | unsigned short int×1 |
| | | | | …. | | |
| | 1438 | - | 1439 | COL360 | gamma ray intensity or elemental concentration | unsigned short int×1 |
| … | | | | …. | | |
| | | | | …. | | |
| Line 360 | 128880 | - | 128881 | COL1 | gamma ray intensity or elemental concentration | unsigned short int×1 |
| | | | | …. | | |
| | 129598 | - | 129599 | COL360 | gamma ray intensity or elemental concentration | unsigned short int×1 |

**Figure 3-2 Format of map data**

## 3.4 Catalog Information File Format

The Catalog Information File Format is shown in Table 3-2.

**Table 3-2 Catalog Information File Format**

| Item Name | Elements | Format of Value | Range of Value | Values |
|---|---|---|---|---|
| Name of the data file (*1) | DataFileName | AAAA….AAAA (Up to 31 digits) | alphanumeric characters | dependent on the product (See Section 3.1 “Rules used for File naming”.) |
| Size of the data file | DataFileSize | NNNNNNNNNNN ((Up to 12 digits) | unit:<byte> | dependent on the product |
| File format of the data file | DataFileFormat | AAAA….AAAA (Up to 16 digits) | character strings | PDS [STATIC] |
| Name of the thumbnail file | ThumbnailFileName | AAAA….AAAA (Up to 31 digits) | alphanumeric characters | dependent on the product (See Section 3.1 “Rules used for File naming”.) |
| Size of the thumbnail file | ThumbnailFileSize | NNNNNNNNNNN (Up to 12 digits) | unit:<byte> | dependent on the product |
| File format of the thumbnail file | ThumbnailFileFormat | AAAA (Up to 4 digits) | JPEG | JPEG [STATIC] |
| Name of the instrument | InstrumentName | AAAA….AAAA (Up to 16 digits) | character strings | GRS [STATIC] |
| Processing level | ProcessingLevel | AAAA….AAAA (Up to 16 digits) | character strings | dependent on the product (See Table 1-2 “Level”) |
| Product ID | ProductID | AAAA….AAAA (Up to 30 digits) | character strings | dependent on the product (See Table 1-2 “Product_ID”) |
| Version number of the product | ProductVersion | AAAA….AAAA (Up to 16 digits) | character strings | dependent on the product |
| Access level | AccessLevel | N | values of 0-4 | N/A |
| Start time | StartDateTime | yyyy- mmddT hh: mm: ss.ssssssZ | DATE & TIME | dependent on the product |
| Stop time | EndDateTime | yyyy- mmddT hh: mm: ss.ssssssZ | DATE & TIME | dependent on the product |
| Upper left latitude of the scene | UpperLeftLatitude | SNN.NNNNNN | -90-90 | 90.0[STATIC] |
| Upper left longitude of the scene | UpperLeftLongitude | NNN.NNNNNN | 0-360 | 0.0[STATIC] |
| Upper right latitude of the scene | UpperRightLatitude | SNN.NNNNNN | -90-90 | 90.0[STATIC] |
| Upper right longitude of the scene | UpperRightLongitude | NNN.NNNNNN | 0-360 | 360.0[STATIC] |
| Lower left latitude of the scene | LowerLeftLatitude | SNN.NNNNNN | -90-90 | -90.0[STATIC] |
| Lower left longitude of the scene | LowerLeftLongitude | NNN.NNNNNN | 0-360 | 360.0[STATIC] |
| Lower right latitude of the scene | LowerRightLatitude | SNN.NNNNNN | -90-90 | -90.0[STATIC] |
| Lower right longitude of the scene | LowerRightLongitude | NNN.NNNNNN | 0-360 | 360.0[STATIC] |
| Latitude of the scene center | SceneCenterLatitude | SNN.NNNNNN | -90-90 | 0.0[STATIC] |
| Longitude of the scene center | SceneCenterLongitude | NNN.NNNNNN | 0-360 | 180.0[STATIC] |
| Band storage type | BandStorageType | - | - | BAND_SEQUENTIAL [STATIC] |

| | | | | |
|---|---|---|---|---|
| | | | | *Refer to the PDS Standard Reference V3.5 Appendix A.19 “IMAGE”. |
| Number of bands | Bands | X | - | 1 [STATIC] |
| Horizontal pixel count of image | LineSamples | XX | - | dependent on the product |
| Vertical pixel count of image | Lines | XX | - | dependent on the product |
| Pixel bit length | SampleBits | - | - | 16[STATIC] |
| Pixel type | SampleType | - | - | MSB_INTEGER<br>MSB_UNSIGNED_INTEGER<br>* Refer to the PDS Standard Reference V3.5 Appendix C.1 and C.2 for further information. |
| Target name | TargetName | - | - | MOON [STATIC] |
| Comment | CommentText | - | character strings | dependent on the product |
| Alternative value outside assumption | InvalidConstant | XXXXXX | - | dependent on the product |
| Alternative value of missing value | MissingConstant | XXXXXX | - | dependent on the product |
| Offset | Offset | X.X | - | dependent on the product |
| Significant bit mask | SampleBitMask | - | - | 1111111111111111 [STATIC] |

(*1) “DataFileName” is the stored file name of the product. For the detached format, this is the stored file name.

### *<Example of Catalog Information: Gamma Ray Intensity Map >*

```
DataFileName = GRS_IMAP_K_071212_080217.img
DataFileFormat = PDS
#
InstrumentName = GRS
ProcessingLevel = Standard
ProductID = GRS_GammaRayMap_A_K
ProductVersion = 1.0
AccessLevel = 1
StartDateTime = 2007-12-14T04:15:06.000000Z
EndDateTime = 2008-02-17T12:09:29.000000Z
#
UpperLeftLatitude = 90.0
UpperLeftLongitude = 0.0
UpperRightLatitude = 90.0
UpperRightLongitude = 360.0
LowerLeftLatitude = -90.0
LowerLeftLongitude = 0.0
LowerRightLatitude = -90.0
LowerRightLongitude = 360.0
SceneCenterLatitude = 0.0
SceneCenterLongitude = 180.0
#
CommentInfo = "this is a sample data, containing the intensity map of gamma rays emitted from Pottasium on lunar subsurface."
FreeKeyword = keyword,T,contents
#
BandStorageType = BAND_SEQUENTIAL
Bands = 1
LineSamples = 360
Lines = 180
SampleBits = 16
SampleType = MSB_UNSIGNED_INTEGER
TargetName = MOON
#
CommentText = "this is a sample data, containing the intensity map of gamma rays emitted from Pottasium on
```

lunar subsurface."
  InvalidConstant = 65535
  MissingConstant = 0
  Offset = 0.0
  SampleBitMask = 1111111111111111
  ThumbnailFileName = GRS_IMAP_K_071212_080217.jpg
  ThumbnailFileSize = 75402
  ThumbnailFileFormat = JPEG
  DataFileSize = 260590