KAGUYA (SELENE)

# Product Format Description

## -Upper-atmosphere and Plasma Imager (UPI)-

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 Upper-atmosphere and Plasma Imager[1](UPI) 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 UPI mission.

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

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

[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 1-1shows 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 UPI 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.
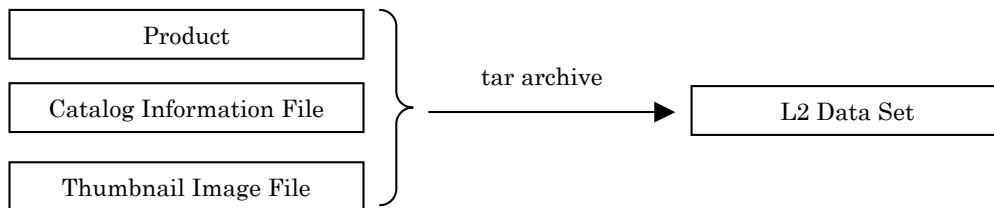


**Figure 1-1   composition of the L2 Data Set**

## 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.



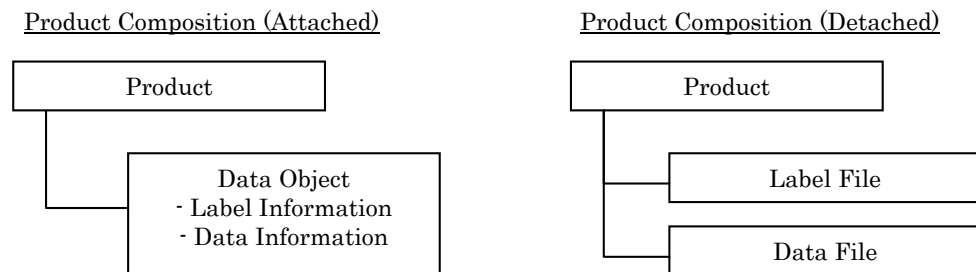**Figure 1-2 Product Composition : Attached and Detached**

(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 UPI Products

The list of UPI 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 UPI Products List

| Level*1 | Product Name | Product ID | Data Type | Product Format*2 |
|---|---|---|---|---|
| Standard | UPI-TEX Plasmasphere image （open data） There are two products: He (30.4nm) and O (83.4nm). | UPI_TEX_plasmasphere_open_a (Add "_He" and "_O" to the end of a string of characters.) | IMAGE | D |
| Standard | UPI-TVIS image （open data） There are six products: OI (557.7nm), OI (630nm), NaI (589.3nm), N2+ (427.8nm), OH (>730nm), dark image. | UPI_TVIS_open_a (Add "_O5", "_O6", "_Na", "_N2", "_OH", "_DK" to the end of a string of characters.) | IMAGE | D |

*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 | Description |
|---|---|
| UPI-TEX plasmasphere image (open data) (HeII(30.4nm)) | UV image of the plasmasphere obtained by UPI-TEX (wavelength: 30.4nm (helium ions), 128x128 pixel, approximately 10-min exposure, in unit of Rayleigh) |
| UPI-TEX plasmasphere image (open data) (OII(83.4nm)) | UV image of the plasmasphere obtained by UPI-TEX (wavelength: 83.4nm (oxygen ions), 128x128 pixel, approximately 10-min exposure, in unit of Rayleigh) |
| UPI-TVIS image （open data） (OI(557.7nm)) | image obtained by UPI-TVIS (wavelength: 557.7nm (atomic oxygen), 512x512 pixel, in unit of Rayleigh) |
| UPI-TVIS image （open data） (OI(630nm)) | image obtained by UPI-TVIS (wavelength: 630.0nm (atomic oxygen), 512x512 pixel, in unit of Rayleigh) |
| UPI-TVIS image （open data） (NaI(589.3nm)) | image obtained by UPI-TVIS (wavelength: 589.2nm (Na), 512x512 pixel, in unit of Rayleigh) |
| UPI-TVIS image （open data） (N2+(427.8nm)) | image obtained by UPI-TVIS (wavelength: 427.8nm (N2+), 512x512 pixel, in unit of Rayleigh) |
| UPI-TVIS image （open data） (OH(>730nm)) | image obtained by UPI-TVIS (wavelength: >730nm (OH), 512x512 pixel, in unit of Rayleigh) |
| UPI-TVIS image （open data） (dark image) | image obtained by UPI-TVIS (dark image, 512x512 pixel, in unit of Rayleigh) |

## 2. UPI-TEX Plasmasphere image

### 2.1 Rules used for File naming

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

**Table 2-1 Rules used for the UPI-TEX Plasmasphere image**

| Data Class | Separator | Date and Time | Separator | Data Processing Level | Extension |
|---|---|---|---|---|---|
| texi | _ | YYMMDDhhmmss | _ | open | .xxx |
| 1 | 2 | 3 | 4 | 5 | 6 |

| No | Items | Digits | Description |
|---|---|---|---|
| 1: | Data Class | 4 | texi : TEX |
| 2: | Separator | 1 | Separator. "_" [STATIC] |
| 3: | Date and Time | 12 | Start Date and Time of Observation.YYMMDDhhmmss |
| 4: | Separator | 1 | Separator. "_" [STATIC] |
| 5: | Data Processing Level | 4 - 6 | Data processing level. open : Open Data |
| 6: | Extension | 4 | .sl2 : L2 Data Set (tar archive) .img :Data Product .lbl :Label Product .ctg :Catalog Information File |

***&lt;Example of Name&gt;***

texi_070214074835_open.sl2

## 2.2 Label Format

The Label format for the IMAGE object used for the UPI-TEX product is shown in Table 2-2. The Label for the UPI-TEX IMAGE object includes: Standard Item, Image Data Object Format Description Part

In Table 2-2 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 2-2 Object Label for the UPI-TEX Plasmasphere image

| No. | Items | Elements | Type | 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 Section2.1 "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 | UPI [STATIC] |
| 7 | Product ID | PRODUCT_SET_ID = %s | char | See Table1-2 "Product_ID". |
| 8 | Product version number | PRODUCT_VERSION_ID = %s | char | Ver.X.X |
| 9 | Target name | TARGET_NAME = %s | char | moon [STATIC] |
| 10 | Comment | COMMENT_TEXT = "%s" | char | |
| 11 | Starting position of the image object | ^IMAGE = %d <BYTES> | int | 0 <BYTES> [STATIC] |
| | | | | |
| **Image Data Object Format Description Part(/* IMAGE */)** | | | | |
| | | OBJECT = IMAGE | | |
| 12 | Vertical pixel count of image | LINES = %d | int | XXX |
| 13 | Horizontal pixel count of image | LINE_SAMPLES = %d | int | XXXXX |
| 14 | Pixel type | SAMPLE_TYPE = %s | char | MSB_INTEGE R[STATIC] * Refer to the PDS Standard Reference V3.5 Appendix C.1 for further information about "MSB_INTEGER". |
| 15 | Pixel bit length | SAMPLE_BITS = %d | int | XX |
| 16 | Band storage type | BAND_STORAGE_TYPE = %s | char | BAND_SEQUENTIAL [STATIC] *Refer to the PDS Standard Reference V3.5 Appendix A.19 "IMAGE". |
| 17 | Number of bands | BANDS = %d | smallint | 1 [STATIC] |
| 18 | Alternative value outside assumption | INVALID_CONSTANT = %s | char | 0 [STATIC] |
| 19 | Offset | OFFSET = %f | float | 0.0 [STATIC] |
| 20 | Scaling factor | ALING_FACTOR = %f | float | 1.0 [STATIC] |
| 21 | Exposure start time | START_TIME = %s | char | YYYY-MM-DDThh:mm:ss |
| 22 | Exposure stop time | STOP_TIME = %s | char | YYYY-MM-DDThh:mm:ss |
| 23 | Gimbal azimuth angle | AZIMUTH_ANGLE = %f | float | -90.000<degree> |
| 24 | Gimbal elevation angle | ELEVATION_ANGLE = %f | float | -100.0000 <degree> |
| 25 | Temperature of TEX MCP | TEX_MCP_TEMPERATURE = %f | float | -40.00< deg C > |
| | | END_OBJECT = IMAGE | | |
| **END statement** | | | | |
| | | END | | |

### *<Example of Label : UPI-TEX Plasmasphere image >*

```
PDS_VERSION_ID          = PDS3
RECORD_TYPE             = UNDEFINED
FILE_NAME               = texi_060505232619_open.img
MISSION_NAME            = SELENE
SPACECRAFT_NAME         = SELENE-M
INSTRUMENT_NAME         = UPI
PRODUCT_SET_ID          = UPI_TEX_moon_level2a
PRODUCT_VERSION_ID      = Ver.1.0
TARGET_NAME             = moon
COMMENT_TEXT            = "Moon HeII 304 image"
^IMAGE                  = 0 <BYTES>

OBJECT =                  IMAGE
   LINES                = 128
   LINE_SAMPLES         = 16384
   SAMPLE_TYPE          = MSB_INTEGER
   SAMPLE_BITS          = 10
   BAND_STORAGE_TYPE    = BAND_SEQUENTIAL
   BANDS                = 1
   INVALID_CONSTANT     = 0
   OFFSET               = 0.0
   SCALING_FACTOR       = 1
   START_TIME           = 2009-01-01T21:00:00
   STOP_TIME            = 2009-01-01T21:00:30
   AZIMUTH_ANGLE        = -90.000
   ELEVATION_ANGLE      = -100.0000
   TEX_MCP_TEMPERATURE = -40.00
END_OBJECT              = IMAGE

   END
```

## 2.3 Data Object Format

The specification for the Data Object Format UPI-TEX is shown as follows.
- Pixel:
  - ✓ UPI-TEX         : 128x128 pixel
- Data Type : Real
- Unit of Measure : Rayleigh

Refer to the following paper on KAGUYA, published in a special issue of the EPS (Earth Planets Space) magazine. This paper describes in-depth the TEX data.

Telescope of extreme ultraviolet (TEX) onboard SELENE: science from the Moon
I. Yoshikawa, A. Yamazaki, G. Murakami, K. Yoshioka, S. Kameda, F. Ezawa, T. Toyota, W. Miyake, M. Taguchi, M. Kikuchi, and M. Nakamura
Earth Planets Space, Vol. 60 (No. 4), pp. 407-416, 2008

## 2.4 Catalog Information File Format

The Catalog Information File Format for the UPI-TEX Plasmasphere image is shown in Table 2-3.

### Table 2-3 Catalog Information File Format for the UPI-TEX Plasmasphere image

| 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 | UPI [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 |

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

*\<Example of Catalog Information : UPI-TEX Plasmasphere image \>*

```
DataFileName      =texi_060505232619_open.img
DataFileSize      =98432
DataFileFormat    =PDS
InstrumentName    =UPI
ProcessingLevel   =Standard
ProductID         =UPI_TEX_moon_level2a
ProductVersion    =1.0
AccessLevel       =4
```

## 3. UPI-TVIS image

### 3.1 Rules used for File naming

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

**Table 3-1 Rules used for the UPI-TVIS image**

| Data Class | Separator | Date and Time | Separator | Data Processing Level | Extension |
|---|---|---|---|---|---|
| tvis | _ | YYMMDDhhmmss | _ | open | .xxx |
| 1 | 2 | 3 | 4 | 5 | 6 |

| No | Items | Digits | Description |
|---|---|---|---|
| 1: | Data Class | 4 | tvis : TVIS |
| 2: | Separator | 1 | Separator. "_" [STATIC] |
| 3: | Date and Time | 12 | Start Date and Time of Observation.YYMMDDhhmmss |
| 4: | Separator | 1 | Separator. "_" [STATIC] |
| 5: | Data Processing Level | 4 - 6 | Data processing level.<br>open : Open Data |
| 6: | Extension | 4 | .sl2 : L2 Data Set (tar archive)<br>.img :Data Product<br>.lbl :Label Product<br>.ctg :Catalog Information File |

***<Example of Name>***
texi_070214074835_open.sl2

## 3.2 Label Format

The Label format for the IMAGE object used for the UPI-TVIS product is shown in Table 3-2. The Label for the UPI-TVIS IMAGE object includes: Standard Item, Image Data Object Format Description Part

In Table 3-2 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 3-2 Object Label for the UPI-TVIS image

| No. | Items | Elements | Type | 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 Section3.1 "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 | UPI [STATIC] |
| 7 | Product ID | PRODUCT_SET_ID = %s | char | See Table 1-2 "Product_ID" |
| 8 | Exposure start time | START_TIME = %s | cahr | YYYY-MM-DDThh:mm:ss |
| 9 | Exposure time | EXPOSURE_TIME = %s | float | XXX <second> |
| 10 | Used filter ID | TVIS_FILTER_ID = %d | int | 0 : CLOSED<br>1 : >730nm<br>2 : Na589nm<br>3 : N2+428nm<br>4 : O630nm<br>5 : O558nm |
| 11 | Gimbal azimuth angle | AZIMUTH_ANGLE = %f | float | XXX.XXX <degree> |
| 12 | Gimbal elevation angle | ELEVATION_ANGLE = %f | float | XXXX.XXXX < degree > |
| 13 | Temperature of TVIS CCD | TVIS_CCD_TEMPERATURE = %f | float | XXX.XX <deg C> |
| 14 | Product version number | PRODUCT_VERSION_ID = %s | char | Ver.X.X |
| 15 | Target name | TARGET_NAME = %s | char | moon [STATIC] |
| 16 | Comment | COMMENT_TEXT = "%s" | char | |
| 17 | Starting position of the image object | ^IMAGE = %d <BYTES> | int | 0 <BYTES> [STATIC] |
| | | | | |
| **Image Data Object Format Description Part(/* IMAGE */)** | | | | |
| | | OBJECT = IMAGE | | |
| 18 | Vertical pixel count of image | LINES = %d | int | XXX |
| 19 | Horizontal pixel count of image | LINE_SAMPLES = %d | int | XXXXX |
| 20 | Pixel type | SAMPLE_TYPE = %s | char | MSB_INTEGE R[STATIC] * Refer to the PDS Standard Reference V3.5 Appendix C.1 for further information about "MSB_INTEGER". |
| 21 | Pixel bit length | SAMPLE_BITS = %d | int | XX |
| 22 | Band storage type | BAND_STORAGE_TYPE = %s | char | BAND_SEQUENTIAL [STATIC] *Refer to the PDS Standard Reference V3.5 Appendix A.19 "IMAGE". |
| 23 | Number of bands | BANDS = %d | smallint | 1 [STATIC] |
| 24 | Alternative value outside assumption | INVALID_CONSTANT = %s | char | 0 [STATIC] |
| 25 | Offset | OFFSET = %f | float | 0.0 [STATIC] |
| 26 | Scaling factor | SCALING_FACTOR = %f | float | 1.0 [STATIC] |
| | | END_OBJECT = IMAGE | | |

| END statement | | | | |
|---|---|---|---|---|
| | | END | | |

### <Example of Label : UPI-TVIS image >

```
PDS_VERSION_ID   =PDS3
RECORD_TYPE              =UNDEFINED
FILE_NAME                =tvis_080209133502_level2.img
MISSION_NAME             =SELENE
SPACECRAFT_NAME          =SELENE-M
INSTRUMENT_NAME          =UPI
PRODUCT_SET_ID           =UPI_TVIS_level2a_DK
START_TIME               = 2008-02-09T13:34:58
EXPOSURE_TIME            =0.125
TVIS_FILTER_ID   =0
AZIMUTH_ANGLE                        =80.1448
ELEVATION_ANGLE                      =23.6155
TVIS_CCD_TEMPERATURE     =-37.03
PRODUCT_VERSION_ID       =Ver.1.0
TARGET_NAME              =moon
COMMENT_TEXT             =Image taken from Lunar orbit
^IMAGE                   =0 <BYTES>

OBJECT =IMAGE
    LINES           =512
    LINE_SAMPLES         =262144
    SAMPLE_TYPE          =MSB_INTEGER
    SAMPLE_BITS          =10
    BAND_STORAGE_TYPE    =BAND_SEQUENTIAL
    BANDS                =1
    INVALID_CONSTANT     =0
    OFFSET               =0.0
    SCALING_FACTOR       =1
END_OBJECT               =IMAGE

END
```

## 3.3 Data Object Format

The specification for the Data Object Format UPI-TVIS is shown as follows.
- ■ Pixel:
  - ✓ UPI-TVIS　　　：512x512 pixel
- ■ Data Type：Real
- ■ Unit of Measure：Rayleigh

## 3.4 Catalog Information File Format

The Catalog Information File Format for the UPI-TVIS image is shown in Table 3-3.

### Table 3-3 Catalog Information File Format for the UPI-TVIS image

| 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 | 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 | UPI [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 |

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

### *<Example of Catalog Information : UPI-TVIS image >*

```
DataFileName        =tvis_080209133502_level2.img
DataFileSize        =1048576
DataFileFormat      =PDS
InstrumentName      =UPI
ProcessingLevel     =Standard
ProductID           =UPI_TVIS_level2a_DK
ProductVersion      =1.0
AccessLevel         =4
```