InSight

Interior Exploration Using Seismic Investigations, Geodesy, and Heat Transport (InSight) Mission

Seismic Experiment for Investigating the Subsurface (SEIS)

PDS Archive

Software Interface Specification

Rev. 1.1

June 24, 2019

Prepared by

Susan Slavney, PDS Geosciences Node, Washington University in St. Louis, Susan.Slavney@wustl.edu

Renee Weber, SEIS Archive Assembly Team, Marshall Space Flight Center, Renee.C.Weber@nasa.gov

InSight

Seismic Experiment for Investigating the Subsurface

PDS Archive

Software Interface Specification

Rev. 1.1

June 24, 2019

Custodian:

_____   _____

Renee Weber   Date

SEIS Archivist

Approved:

_____   _____

Philippe Lognonné   Date

SEIS Principal Investigator

_____   _____

Raymond E. Arvidson   Date

PDS Geosciences Node Manager

Contents

List of Tables

1   Introduction

This software interface specification (SIS) describes the format and content of data acquired by the Seismic Experiment for Investigating the Subsurface (SEIS) instrument for the Planetary Data System (PDS) data archive. It includes descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline. This SIS concerns raw data products only. For calibrated products, see section 3.2.1. Derived SEIS data products are described in separate SIS documents.

1.1   Document Change Log

Table 1: Document Change Log

Version	Change	Date	Affected portion
0.1	- Initial draft	July 10, 2014	All
0.2	- Updates to SEIS instrument specifications and data descriptions	Dec. 3, 2014	2.2, 2.6, 3.1, 3.2.2, 3.3.1, 3.3.2, 3.4, 4.4.3
0.3	- Formatting - Additions to SEIS Archive Organization - Additions to SEIS Raw Data Product Formats	May 26, 2015	4, 4.1, 4.1.1, 4.1.2, 4.1.3, 4.2, 4.4, 4.5, 5.1.1, 5.1.2
0.4	- Updated TBD items (Table 2) - Additions to Abbreviations (Table 3) - Clarification to purpose & scope - clarification to measured parameters & calibration - Updates to applicable documents - Clarification to Data Product Overview, processing, & Generation - Clarification to Data Flow, Time Standards, & Coordinate Systems - Removed SISMOC TCT from Applicable Software - updated filename convention	Nov. 16, 2015	1.2, 1.3, 2.1, 2.3, 2.6.4, 2.6.6, 3.1, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4, 4.1.3
0.5	-Updated Applicable Documents, InSight Mission description dates, SEIS description	May 10, 2018	2.3, 2.5, 2.6.2, 3.1
0.6	- Updated 3.2, 4.x, 5.x	May 31, 2018	Added descriptions and references for dataless SEED, GeoCSV, and StationXML file types.
1.0	- Updated in response to peer review comments	October 5, 2018	Many
1.0	- Revised App. Doc. 11, corrected directory names, added labels	March 27, 2019	2.3, 4.1.3, Appendix B

| 1.0 | Removed SISMOC Mini-SEED implementation document from Applicable Documents, as it is not generally available | May 21, 2019 | 2.3 |
| 1.1 | Revised examples of event data file names | June 24, 2019 | 4.1.3 |

1.2 TBD Items

Table 2 lists items that are not yet finalized.

Table 2: List of TBD items

Item	Section(s)	Page(s)
None		

1.3 Abbreviations

Table 3: Abbreviations and Their Meanings

Abbreviation	Meaning
AOBT	APSS On-Board Time
ASCII	American Standard Code for Information Interchange
CNES	Centre National d'Etudes Spatiales
CODMAC	Committee on Data Management, Archiving, and Computing
CCSDS	Consultative Committee for Space Data Systems
EDR	Experiment Data Record
GB	Gigabyte(s)
GEO	PDS Geosciences Node (Washington University, St. Louis, Missouri)
ICD	Interface Control Document
IM	Information Model
IPGP	Institut de Physique du Globe de Paris
IRIS	Incorporated Research Institutions for Seismology
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory (Pasadena, CA)
LID	Logical Identifier
LIDVID	Versioned Logical Identifier
LOBT	SEIS On-Board Time

Abbreviation	Meaning
LVL	SEIS Leveling System
MB	Megabyte(s)
MD5	Message-Digest Algorithm 5
MSDS	Mars SEIS Data Service
NAIF	Navigation and Ancillary Information Facility (JPL)
NASA	National Aeronautics and Space Administration
NSSDCA	National Space Science Data Coordinated Archive (GSFC)
PDS	Planetary Data System
PDS4	Planetary Data System Version 4
SCLK	Spacecraft Clock
SEED	Standard for the Exchange of Earthquake Data
SEIS	Seismic Experiment for Investigating the Subsurface
SIS	Software Interface Specification
SISMOC	SEIS on Mars Operation Center
SP	Short Period
TBD	To Be Determined
URN	Uniform Resource Name
VBB	Very Broad Band
WU	Washington University in St. Louis
WTS	Wind and Thermal Shield
XML	eXtensible Markup Language

1.4 Glossary

Many of these definitions are taken from Appendix A of the PDS4 Concepts Document, https://pds.nasa.gov/datastandards/documents/concepts/. The reader is referred to that document for more information.

Archive – A place in which public records or historical documents are preserved; also the material preserved – often used in plural. The term may be capitalized when referring to all of PDS holdings – the PDS Archive.

Basic Product – The simplest product in PDS4; one or more data objects (and their description objects), which constitute (typically) a single observation, document, etc. The only PDS4 products that are *not* basic products are collection and bundle products.

Bundle Product – A list of related collections. For example, a bundle could list a collection of raw data obtained by an experiment during its mission lifetime, a collection of the calibration products associated with the experiment, and a collection of all documentation relevant to the first two collections.

Class – The set of attributes (including a name and identifier) which describes an item defined in the PDS Information Model. A class is generic – a template from which individual items may be constructed.

Collection Product – A list of closely related basic products of a single type (e.g. observational data, browse, documents, etc.). A collection is itself a product (because it is simply a list, with its label), but it is not a *basic* product.

Data Object – A generic term for an object that is described by a description object. Data objects include both digital and non-digital objects.

Description Object – An object that describes another object. As appropriate, it will have structural and descriptive components. In PDS4 a 'description object' is a digital object – a string of bits with a predefined structure.

Digital Object – An object which consists of real electronically stored (digital) data.

Identifier – A unique character string by which a product, object, or other entity may be identified and located. Identifiers can be global, in which case they are unique across all of PDS (and its federation partners). A local identifier must be unique within a label.

Label – The aggregation of one or more description objects such that the aggregation describes a single PDS product. In the PDS4 implementation, labels are constructed using XML.

Logical Identifier (**LID**) – An identifier which identifies the set of all versions of a product.

Versioned Logical Identifier (LIDVID) – The concatenation of a logical identifier with a version identifier, providing a unique identifier for each version of product.

Manifest - A list of contents.

Metadata – Data about data – for example, a 'description object' contains information (metadata) about an 'object.'

Object – A single instance of a class defined in the PDS Information Model.

PDS Information Model – The set of rules governing the structure and content of PDS metadata. While the Information Model (IM) has been implemented in XML for PDS4, the model itself is implementation independent.

Product – One or more tagged objects (digital, non-digital, or both) grouped together and having a single PDS-unique identifier. In the PDS4 implementation, the descriptions are combined into a single XML label. Although it may be possible to locate individual objects within PDS (and to

find specific bit strings within digital objects), PDS4 defines 'products' to be the smallest granular unit of addressable data within its complete holdings.

Tagged Object – An entity categorized by the PDS Information Model, and described by a PDS label.

Registry – A data base that provides services for sharing content and metadata.

Repository – A place, room, or container where something is deposited or stored (often for safety).

XML – eXtensible Markup Language.

XML schema – The definition of an XML document, specifying required and optional XML elements, their order, and parent-child relationships.

2 Overview

2.1 Purpose and Scope

The purpose of this SIS (Software Interface Specification) document is to provide users of the SEIS archive with a detailed description of the data products and how they are generated, along with a description of the PDS4 archive bundle, the structure in which the data products, documentation, and supporting material are stored. The users for whom this document is intended are the scientists who will analyze the data, including those associated with the project and those in the general planetary science community.

This SIS covers raw data products generated by SEIS that are archived in the Planetary Data System (PDS). In particular, these products consist of the science measurements downlinked from the SEIS instrument and stored in SEED (Standard for the Exchange of Earthquake Data) format, and the same measurements converted to ASCII text tables in a PDS4-compatible format.

2.2 SIS Contents

This SIS describes how the SEIS instrument acquires data, and how the data are processed, formatted, labeled, and uniquely identified. The document discusses standards used in generating the data products and software that may be used to access the products. The data structure and organization are described in sufficient detail to enable a user to read and understand the data.

Appendices include a description of the file naming conventions used in the SEIS archive, and a list of cognizant persons involved in generating the archive.

2.3 Applicable Documents

[1] Planetary Data System Standards Reference, Version 1.10.0, April 1, 2018.

[2] Planetary Science Data Dictionary Document, Version 1.10.0.0, March 21, 2018.

[3] Planetary Data System (PDS) PDS4 Information Model Specification, Version 1.10.0.0, March 21, 2018.

[4] Data Providers' Handbook: Archiving Guide to the PDS4 Data Standards, Version 1.10.0, April 1, 2018.

[5] InSight Archive Generation, Validation, and Transfer Plan, Rev. A 2017 v1, August 16, 2017.

[6] SEIS Science Team and PDS Geosciences Node Interface Control Document (ICD), April 14, 2014.

[7] SEED Reference Manual, SEED Format Version 2.4, International Federation of Digital Seismograph Networks, Incorporated Research Institutions for Seismology, United States Geological Survey, August 2012.
http://www.fdsn.org/seed_manual/SEEDManual_V2.4.pdf

[8] InSight SEIS seismometer SEED Channel Configuration for ELYS station, Ref: INS-ST-GRDS-1500-IPGP_SEED_ChannelNaming, version 2.8, January 17, 2019.

[9] rdseed software manual. rdseed version 5.3.1 is current as of 12/12/2014 http://ds.iris.edu/ds/nodes/dmc/manuals/rdseed/.

[10] Lognonne, P., W. B. Banerdt, D. Giardini, et al., SEIS: InSight's Seismic Experiment for Internal Structure of Mars (2019), Space Sci. Rev. 215:12, doi:10.1007/s11214-018-0574-6.

6

[11] SEIS Derived Product Software Interface Specification, to be written.

[12] GeoCSV – Tabular Text Formatting for Geoscience Data, version 2.0.4, July 21, 2015, Incorporated Research Institutions for Seismology (IRIS), http://geows.ds.iris.edu/documents/GeoCSV.pdf.

[13] FDSN StationXML Schema, International Federation of Digital Seismograph Networks (FDSN), version 1.0, https://www.fdsn.org/xml/station.

The PDS4 Documents [1] through [3] are subject to revision. The most recent versions may be found at pds.nasa.gov. The SEIS PDS4 products specified in this SIS have been designed based on the versions current at the time, which are those listed above.

2.4 Audience

This document serves both as a Data Product SIS and an Archive SIS. It describes the format and content of SEIS data products in detail, and the structure and content of the archive in which the data products, documentation, and supporting material are stored. This SIS is intended to be used both by the instrument teams in generating the archive, and by data users wishing to understand the format and content of the archive. Typically these individuals would include scientists, data analysts, and software engineers.

2.5 InSight Mission

InSight was launched on May 5, 2018. The mission consists of a single geophysical lander to be placed on the surface of Mars on November 26, 2018, to study its interior structure. The Surface Phase consists of Deployment and Penetration, and Science Monitoring. It ends after one Mars year plus 40 sols.

The science payload comprises two experiments: the Seismic Experiment for Investigating the Subsurface (SEIS) and the Heat-Flow and Physical Properties Probe (HP^3). In addition, the Rotation and Interior Structure Experiment (RISE) uses the spacecraft X-band communication system to provide precise measurements of planetary rotation. SEIS and HP^3 are placed on the surface with an Instrument Deployment System (IDS) comprising an Instrument Deployment Arm (IDA), Instrument Deployment Camera (IDC), and Instrument Context Camera (ICC). There are also several supporting experiments. The Auxiliary Payload Sensor Subsystem (APSS) includes the pressure sensor, the magnetometer, and Temperature and Wind for InSight (TWINS) sensors and collects environmental data in support of SEIS. These data are used by SEIS to reduce and analyze the seismic data. The radiometer (RAD) is used by the HP^3 team to measure surface temperature and thermal properties to support the thermal data analysis.

2.6 SEIS Instrument Description

The SEIS [10] instrument measures seismic activity on the surface of Mars over a very broad frequency band, from tidal frequencies (0.05 mHz) up to high frequencies (50 Hz), to address a wide range of scientific questions. The instrument includes a Very Broad Band (VBB) 3-axis seismometer and a MEMS (microelectromechanical systems) Short-Period (SP) 3-axis seismometer. Both are mounted on a precision leveling structure (LVL) together with their respective signal preamplifier stages. The sensor assembly is deployed from the lander platform to the ground by a robotic arm, and is protected on the surface by a Wind and Thermal Shield

(WTS). The WTS, together with the vacuum sphere enclosure and a passive compensation system, protect the seismometers against temperature and pressure variations, allowing the sensors to operate optimally in the rough Martian thermal environment.

2.6.1 Science Objectives

The objective of the SEIS experiment is the determination of the deep internal structure of Mars, particularly prime geophysical parameters such as the state (liquid/solid) and size of the core, structure of the mantle, shape of discontinuities and thickness of the crust. SEIS will also constrain the meteoritic impact rate, marsquake rate, and the response of the planet to the tide raised by Mars' largest moon, Phobos.

2.6.2 Detectors

SEIS consists of two three-axis seismometers, one Short Period (SP), and one Very Broad Band (VBB), to measure ground motion generated by seismic waves traveling through the interior. The VBB displacement transducers are a trio of orthogonal, inverted pendula stabilized with a leaf spring and tuned for Mars gravity. A differential capacitive sensor detects movement of the instrument housing relative to the pendula, which are continuously re-centered by a magnetic coil actuator using analog feedback. The velocity output is derived from the differential component of the analog feedback signal.

SP is a micro-fabricated triad of monolithic in-plane silicon proof mass/folded-cantilever suspensions, with electroplated coils and capacitive sensors driving analog feedback circuits.

During science operations, VBB is continuously sampled at 20 Hz and SP is continuously sampled at 100 Hz.

2.6.3 Electronics

SEIS is tethered to a separate electronics (E-) box. The E-box provides conditioned power to the sensor head, acquires the pre-amplified seismometer signals, provides analog feedback, and integrates environmental and housekeeping sensor data into the data stream. The E-box is configured as a state machine, with logical instrument control, data processing, and data packaging provided by the SEIS software resident in the Lander Command & Data Handling (C&DH). Available states are OFF, INIT/SAFE, and OPNL (operational). INIT/SAFE mode includes the leveling sub-mode. The OPNL mode has two sub-modes: full science, and re-centering. Re-centering accommodates mechanical drift of the VBB sensors, and occurs infrequently.

2.6.4 Measured Parameters

SEIS measures ground motion in Digital Units (DU), which are proportional to within 10 dB to ground acceleration (distance/time^2) for the VBB-POS output and velocity (distance/time) for the VBB-VEL and SP outputs.

2.6.5 Operational Modes

Each of the three VBB channels operates in both velocity and position modes, with high or low gain, and in either science mode or engineering mode, for a total of 24 operational modes.

Each of the three SP channels operates with either high or low gain, for a total of 6 modes.

2.6.6 Calibration

SEIS employs standard seismological calibration techniques prior to launch and throughout surface operations. Pulses of known current are periodically applied to calibration coils (~1/week) to deflect the VBB and SP pendulums, thereby providing the instrument response function that will be used to tie instrument performance to pre-launch calibration. Calibration information will be updated in the SEIS metadata approximately every 3 months. Changes to instrument conditions (e.g. seasonal temperature changes, re-levelling) and lander operations that could generate perturbations (e.g. arm operations) will be documented in the InSight Analyst's Notebook, separate from the PDS archive.

3   SEIS Raw Data Products

3.1   Data Product Overview

VBB and SP will both generate data continuously. Flight software configuration decides whether data is downlinked on Earth continuously, or by event. Continuous data will be divided into products that span one Earth day, midnight to midnight UTC. Event data will be stored as one product per event. An event may last several minutes.

SEIS data products will be downlinked from the spacecraft in raw CCSDS packets and converted to both SEED format files and ASCII tables (GeoCSV) for analysis and archiving.

3.2   Data Processing

This section describes the processing of SEIS data products, their structure and organization, and their labeling.

3.2.1   Data Processing Levels

Data processing levels mentioned in this SIS refer to PDS4 processing levels. Table 4 provides a description of these levels along with the equivalent designations used in other systems.

Table 4: Data Processing Level Definitions

PDS4 processing level	PDS4 processing level description
Raw	Original data from an experiment. If compression, reformatting, packetization, or other translation has been applied to facilitate data transmission or storage, those processes are reversed so that the archived data are in a PDS approved archive format. Often called EDRs (Experimental Data Records).
Partially Processed	Data that have been processed beyond the raw stage but which have not yet reached calibrated status. These and more highly processed products are often called RDRs (Reduced Data Records).
Calibrated	Data converted to physical units, which makes values independent of the experiment.
Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as 'derived' data if not easily matched to one of the other three categories.

SEIS data products described in this SIS are raw data. Rather than creating calibrated data products by transforming the seismic data to physical units, the SEIS Team uses the SEED standard to provide the complete transfer function enabling that transformation. Therefore the SEED dataless header files, which describe the transfer function, will be revised throughout the mission as better calibration information becomes available.

SEIS derived products consist of a seismic source catalog, a seismic velocity profile, and an instrument transfer function. These products will be delivered at the end of the mission and are described in a separate Software Interface Specification document [11].

3.2.2 Data Product Generation

The SEIS Operation Center (SISMOC) at the Centre National d'Etudes Spatiales (CNES) has developed a Mini-SEED generation tool for translation of the raw spacecraft CCSDS packets into Mini-SEED format. The tool accepts as input packets containing time information, meta-data (calibration, re-centering, leveling info, etc), science data, and housekeeping data. The time packets are used to convert the spacecraft clock stamps to UTC. Meta-data packets are used to fill the Mini-SEED header. Science and housekeeping packets are converted to Mini-SEED records. The science packets are first decompressed from the SEIS-specific spacecraft compression algorithm (STEIM-like), and then compressed using the STEIM2 standard to fill the SEED records.

SEIS samples three continuous VBB components at 2sps, an estimation of the short period energy content from the SP at 1 sps, and a continuous compound VBB/SP vertical axis at 10 sps. There will be 30 Mbit total of raw data downlinked from the spacecraft (as telemetry packets) per day. On the ground, SISMOC will create several continuous data files, one file per UTC day for each channel/location code pair specified in the Channel Configuration spreadsheet [8].

3.2.3 Data Flow

This section describes only those portions of the InSight data flow that are directly connected to SEIS archiving. A full description of the InSight data flow is provided in the InSight Archive Generation, Validation, and Transfer Plan [5].

SEIS data are downlinked by InSight Project Operations at JPL. The JPL Advanced Multimission Operations System (AMMOS) Multimission Image Processing Laboratory (MIPL) delivers raw CCSDS telemetry packets to the SEIS team and to the SISMOC Data Center at CNES. The team extracts raw SEIS data in Mini-SEED format from the telemetry and delivers it to the Mars SEIS Data Service (MSDS) located at Institut de Physique du Globe de Paris (IPGP). MSDS sends the Mini-SEED raw data and completed (preliminary or validated) metadata in both dataless SEED and StationXML format to Incorporated Research Institutions for Seismology (IRIS) and to the SEIS Archive Assembly Team at Marshall Space Flight Center. IRIS converts these data using their standard web services to ASCII format (GeoCSV), for delivery to the Archive Assembly Team. The Archive Assembly Team generates PDS4 labels for the data products, assembles the SEIS raw data archive bundle and delivers it to the PDS Geosciences Node. The full bundle consists of A) SEIS data in Mini-SEED format, paired with a dataless SEED metadata file, B) the same data in GeoCSV format, paired with a StationXML metadata file, and C) the PDS4 labels for both. The Geosciences Node validates the delivery and makes it available online for public use.

3.2.4 Data Delivery Schedule

Data deliveries and releases take place according to the release schedule agreed upon by the InSight Project and PDS and specified in the InSight Archive Plan, Table 2-5. The initial release of all instruments' raw data archive products by the PDS to the public is scheduled to occur in April 2019, three months after receipt of the first raw science data from the spacecraft. The corresponding calibrated products and SPICE kernels will be released one month later. Following

these initial releases, the raw, calibrated and SPICE data will be released together by the PDS every three months beginning in July 2019.

SEIS data products will be delivered by the SEIS Archive Assembly Team to the PDS Geosciences Node at least three weeks before each scheduled release by PDS to the public.

SEIS data are expected to be of high interest to the scientific community and to the public at large. Therefore, three months after the initial release by PDS described above, the Mars SEIS Data Service will begin releasing uncertified SEIS velocity data on the Mars SEIS Data Service website about two weeks after the data have been received. It is recognized that this early public release of data may not be of archive quality, and therefore may be revised by the time it is delivered to the PDS. The early released data will be clearly marked as preliminary and uncertified, and its release will be done only in SEED.

3.3 Standards Used in Generating Data Products

SEIS products and labels comply with Planetary Data System standards, including the PDS4 data model, as specified in applicable documents [1], [2] and [3].

3.3.1 Time Standards

Data records at Mars surface are stamped using APSS On-Board Time (AOBT) or SEIS On-Board Time (LOBT) counts. Time conversion to local time at the landing site (Local Mean Solar Time, LMST) or UTC for the SEED data will take place at SISMOC via the SISMOC time correlation tool.

3.3.2 Coordinate Systems

The coordinates of the station on Mars will be recorded using the Mars mapping convention, planetocentric coordinate system referenced to the IAU/IAG 2000 frame[1]. Note this is different from the terrestrial seismology standard geographic coordinate system. The orientation of SEIS will be known to within ±5° via sun-dial direction.

3.3.3 Data Storage Conventions

Each SEIS raw data product is stored in two formats, Mini-SEED and ASCII (GeoCSV). The data are downlinked from the spacecraft in CCSDS packets and converted to Mini-SEED format, an international standard for storing seismic data [7]. They are also converted to PDS4-compliant ASCII tables (GeoCSV) to meet PDS4 archiving requirements. The SEIS archive includes both formats for each raw data product. The content is the same in both formats. See section 5.1 for details on both formats.

3.4 Applicable Software

SEIS SEED data may be read using the "rdseed" software package distributed by IRIS. Users must submit a request to download the free software, available here:

   http://ds.iris.edu/ds/nodes/dmc/forms/rdseed/

Rdseed enables conversion of SEED to a variety of seismological data analysis standards. rdseed is a command-line tool available for Mac OS X, Sun Solaris, Linux and other UNIX platforms. It

---

[1] Golombek et al., 2017. https://link.springer.com/article/10.1007%2Fs11214-016-0321-9

also runs on Windows when the user has installed Cygwin. The rdseed version 5.3.1 is current as of 12/12/2014, although the end user should note that it is no longer maintained by IRIS. The manual is available here: http://ds.iris.edu/ds/nodes/dmc/manuals/rdseed/ [9].

Rdseed can also easily convert SEED data to ASCII tables, which, similarly to the GeoCSV format, may be read using many text editors and spreadsheet programs. SEED format data may also be read using the ObsPy Python environment (https://github.com/obspy/obspy/wiki), as well as MATLAB
(https://www.mathworks.com/matlabcentral/fileexchange/28803-rdmseed-and-mkmseed--read-and-write-miniseed-files).

3.5 Backups and duplicates

The Geosciences Node keeps two copies of each archive product. One copy is the primary online archive copy, another is a backup copy. Once the archive products are fully validated and approved for inclusion in the archive, a third copy of the archive is sent to the National Space Science Data Coordinated Archive (NSSDCA) for long-term preservation in a NASA-approved deep-storage facility. The Geosciences Node will maintain additional copies of the archive products off-site as deemed necessary.

4   SEIS Archive Organization, Identifiers and Naming Conventions

This section describes the basic organization of the SEIS raw data archive under the PDS4 Information Model (IM) (Applicable Documents [1] and [3]), including the naming conventions used for the bundle, collection, and product unique identifiers. The formation of logical identifiers is described in section 4.1. Bundles, collections and products are defined and given identifiers in section 4.2. In short, a group of related products forms a collection, and a group of related collections forms a bundle.

4.1   Logical Identifiers

Every product in PDS is assigned an identifier that allows it to be uniquely identified across the system. This identifier is referred to as a Logical Identifier or LID. Each product also has a Version Identifier (VID) that allows different versions of a specific product to be referenced uniquely. A product's LID and VID are defined as separate attributes in the product label. For convenience they may be combined in a single string called a LIDVID, with two colons between the LID and the VID. If a particular version of a product is desired, the LIDVID should be used; otherwise the LID alone should be used with the understanding that it refers to the latest version of the product.

LIDs and VIDs are assigned by PDS and are formed according to the conventions described in the following sections. The uniqueness of a product's LIDVID may be verified using the PDS Registry and Harvest tools. More information on LIDs and VIDs may be found in section 6d of the PDS Standards Reference [1] and in chapter 5 of the Data Providers' Handbook [4].

4.1.1   LID Formation

LIDs take the form of a Uniform Resource Name (URN). LIDs are restricted to ASCII lower case letters, digits, dash, underscore, and period. Colons are also used, but only to separate prescribed components of the LID. Within one of these prescribed components dash, underscore, or period are used as separators. LIDs are limited in length to 255 characters.

InSight SEIS LIDs are formed according to the following conventions:

- Bundle LIDs are formed by appending a bundle specific ID to the PDS base ID:

    urn:nasa:pds:<bundle ID>

    Example: urn:nasa:pds:insight_seis

  The bundle ID must be unique across all bundles archived with the PDS.

- Collection LIDs are formed by appending a collection specific ID to the collection's parent bundle LID:

    urn:nasa:pds:<bundle ID>:<collection ID>

    Example: urn:nasa:pds:insight_seis:data_seed

  The collection ID must be unique across the bundle. Collection IDs correspond to the collection type (e.g. "browse", "data", "document", etc.). Additional descriptive information may be appended to the collection type (e.g. "data-raw", "data-calibrated", etc.) to insure that multiple collections of the same type within a single bundle have unique LIDs.

- Basic product LIDs are formed by appending a product-specific ID to the product's collection LID:

    urn:nasa:pds:<bundle ID>:<collection ID>:<product ID>

    Example: urn:nasa:pds:insight_seis:data_seed:xb.elys.00.lmv.2017.100.1

The product ID must be unique across the collection. For SEIS data products, the product LID is the same as the lower case data file name without the extension.

4.1.2 VID Formation

Product Version IDs consist of major and minor components separated by a "." (M.n). Both components of the VID are integer values. The major component is initialized to a value of "1", and the minor component is initialized to a value of "0". The minor component resets to "0" when the major component is incremented. The PDS Standards Reference [1] specifies rules for incrementing major and minor components.

4.1.3 File Naming Conventions

4.1.3.1 Mini-SEED Data Files

For continuous science packets, one single file is created per UTC day for each Mini-SEED channel/location code pair. For data coming from the event buffers, one file per event for each channel/location code pair is created.

The directory and filename convention for continuous data is:

directory name **data/<NETWORK>/continuous_waveform/<STATION>/<YEAR>/<JDAY>**

file name **NET.STA.LOC.CHAN.YEAR.JDAY.REV.EXT**

where:

- NET is the Network ID,
- STA is the Station ID,
- LOC is the location ID,
- CHAN is the channel ID,
- YEAR is the earth year of the measurement,
- JDAY is the day-of-year (on Earth),
- REV is the revision of the file,
- EXT is file name extension (mseed for SEED format or csv for ASCII Table format).

An example file name is **xb.elyse.00.hhu.2019.042.1.mseed**.

Similarly, the directory and filename convention for event data is

directory name **data/<NETWORK>/event_waveform/<STATION>/<REQEVID>**

file name **NET.STA.LOC.CHAN.REQEVID.REV.EXT**

where:

- NET is the Network ID,

- STA is the Station ID,

- LOC is the location ID,

- CHAN is the channel ID,

- REQEVID the event ID as expressed in the event request and identified in the Mars Quake Service catalog,

- REV is the revision of the file,

- EXT is the file name extension (mseed for SEED format or csv for ASCII Table format)

An example file name is **xb.elyse.02.mhu.mqs2019drgb.1.mseed**.

Location (LOC) and channel codes (CHA) are unique identifiers for instrument sensor (VBB/SP), axis, velocity/position, and sample rate – see InSight SEIS seismometer SEED Channel Configuration for ELYS station [8].

4.1.3.2 Dataless SEED Header Files

A dataless SEED volume contains metadata only. These metadata are necessary to properly analyze the waveform data and include station coordinates, channel orientations, instrument response parameters, sample rate, timing information, etc. A dataless SEED volume is used in combination with a Mini-SEED volume. A dataless file, by definition, contains no "data", in the sense that no waveform data are included, only headers. Dataless SEED is the reference for the metadata; it will be converted to stationXML (see section 4.1.4.3) using IRIS's stationXML to SEED converter[2].

Directory name: **data/<NETWORK>/metadata/<STATION>**

File name: **dataless.<NET>.<STATION>.<YEAR>.<JDAY>.seed**

Example: **dataless.xb.elyse.2019.042.seed**

4.1.3.3 ASCII Data Files in GeoCSV

The ASCII text equivalent of a Mini-SEED data file uses the GeoCSV convention for comma-separated value tables [12]. The file name is the same as the Mini-SEED file name, except that it ends in "a.csv" instead of ".mseed". The corresponding label file name ends in "a.xml".

4.1.3.4 ASCII Header Files in StationXML

The ASCII text equivalent of a dataless SEED header file, which contains metadata for Mini-SEED files, uses the StationXML format for seismic metadata [13]. StationXML files are written in eXtensible Markup Language (XML) and normally have the file name extension ".xml". As this conflicts with PDS4 labels, whose file names also end in ".xml", the StationXML file names use the extension ".sxml".

Directory name: **data/<NETWORK>/metadata/<STATION>**

File name: **stationxml.<NET>.<STATION>.<YEAR>.<JDAY>.sxml**

---

[2] https://seiscode.iris.washington.edu/projects/stationxml-converter

Example: **stationxml.xb.elyse.2019.042.sxml**

4.1.3.5 Examples

Examples of SEIS data product file names are given in Table 5.

Table 5: Example File Names for SEIS Data Products and Labels

Data File Type	Data File Name	Label File Name
Mini-SEED Continuous	xb.elyse.00.hhu.2019.042.1.mseed	xb.elyse.00.hhu.2019.042.1.xml
ASCII GeoCSV Continuous	xb.elyse.00.hhu.2019.042.1.a.csv	xb.elyse.00.hhu.2019.042.1.a.xml
Mini-SEED Event	xb.elyse.02.mhu.mqs2019drgb.1.mseed	xb.elyse.02.mhu.mqs2019drgb.1.xml
ASCII GeoCSV Event	xb.elyse.02.mhu.mqs2019drgb.1.a.csv	xb.elyse.02.mhu.mqs2019drgb.1.a.xml
Dataless SEED Header	dataless.xb.elyse.2019.042.seed	dataless.xb.elyse.2019.042.xml
ASCII StationXML Header	stationxml.xb.elyse.2019.042.sxml	stationxml.xb.elyse.2019.042.xml

4.2 Bundles

The highest level of organization for a PDS archive is the bundle. A bundle is a set of one or more related collections which may be of different types. A collection is a set of one or more related basic products which are all of the same type. Bundles and collections are logical structures, not necessarily tied to any physical directory structure or organization.

The complete InSight SEIS archive is organized into one bundle (Table 6).

Table 6: SEIS Bundles

Bundle Logical Identifier	PDS4 Processing Level	Description
urn:nasa:pds:insight_seis	Raw, Derived	SEIS Data Bundle

In addition to the SEIS data bundle, the InSight archives have a Document Bundle that contains documentation for all InSight data bundles, including SEIS documents. The contents of the Document Bundle are described in section 4.5.

4.3 Collections

Collections consist of basic products all of the same type. The SEIS Bundle contains the collections listed in Table 7.

Table 7: Collections in the SEIS Bundle

Collection Logical Identifier	Collection Type	Description
urn:nasa:pds:insight_seis:data_seed	SEED Data	Contains raw SEIS measurements in SEED format.
urn:nasa:pds:insight_seis:data_table	ASCII Table Data	Contains raw SEIS measurements converted from SEED format to PDS4-compliant ASCII tables (GeoCSV).
urn:nasa:pds:insight_seis:data_derived	Derived catalogs and model	SEIS derived products consist of a seismic source catalog, a seismic velocity profile, and an instrument transfer function.

4.4 Products

A SEIS data product consists of one digital object in one file, accompanied by a PDS label file. The PDS label provides identification and description information for the data file. As discussed above, the PDS label includes a Logical Identifier (LID) by which the product is uniquely identified throughout all PDS archives. Under the PDS4 standard, labels are XML-formatted ASCII files.

The PDS4 standard limits the formats of science data products to a small set of structures. Supplementary information for science products may be provided in a wider variety of formats. The SEED format does not fit any PDS4-compliant format for science data. Therefore each SEIS data product will be archived in two formats: an ASCII table as the primary science data product (GeoCSV), and a SEED file as a supplementary product.

4.5 InSight Document Bundle and Collections

Documents are also considered products in PDS, and have LIDs, VIDs and PDS4 labels just as data products do. The InSight archives include an InSight Document Bundle, which consists of collections of documents relevant to the mission itself and all the science experiments.

Table 8: Collections in the InSight Document Bundle

Collection Logical Identifier	Description
urn:nasa:pds:insight_documents:document_mission	InSight mission, spacecraft and lander descriptions
urn:nasa:pds:insight_documents:document_apss	APSS SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_camera	Camera SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_hp3rad	HP^3/RAD SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_ida	IDA SIS, instrument description, and other relevant documents

urn:nasa:pds:insight_documents:document_mag	MAG SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_rise	RISE SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_seis	SEIS SIS (this document), instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_spice	SPICE relevant documents

The collection **urn:nasa:pds:insight_documents:document_seis** is a primary member of the InSight Document Bundle and is a secondary member of the InSight SEIS bundle. In PDS4 a collection may belong to multiple bundles. It is a primary member of one bundle – the one on which its LID is based – and a secondary member of the other bundles. The actual products that comprise the collection are found in the bundle where it is a primary member. They do not have to be duplicated in the other bundles, although they may be.

5   SEIS Raw Data Product Formats

Data that comprise the SEIS raw data archive are formatted in accordance with PDS specifications (see Applicable Documents [1], [2] and [3]). This section provides details on the formats used for each of the products included in the archive.

5.1   Data Product Formats

Each SEIS raw data product is stored in two formats, SEED and ASCII text (GeoCSV). The SEIS Team and IRIS receive the data in SEED format; IRIS converts it to PDS-compliant ASCII tables (GeoCSV) to meet PDS archiving requirements. Both versions are included in the archive.

5.1.1   Mini-SEED and Dataless SEED File Structure

The SEED Reference Manual [7] describes the format of SEED data files, including the specific variations known as "data only" SEED or Mini-SEED, which is used for SEIS data, and dataless SEED, which contains metadata for the Mini-SEED files.

Each SEIS product in SEED format is accompanied by a PDS4 label. An example label is given in Appendix B.

5.1.2   ASCII GeoCSV Table Data File Structure

Each Mini-SEED data file has a PDS-compliant ASCII table counterpart formatted as a comma-separated value (CSV) table. The table uses the GeoCSV convention for columns and header records as described in the GeoCSV documentation [12]. In order to be PDS-compliant, the table must have only one set of header records, which must occur at the beginning of the file.

Each SEIS product in ASCII CSV table format is accompanied by a PDS4 label. An example label is given in Appendix B.

5.1.3   ASCII StationXML Metadata File Structure

Each Dataless SEED file has a PDS-compliant ASCII text counterpart formatted as a StationXML file [13]. Each StationXML file is accompanied by a PDS4 label. As both the StationXML file and PDS4 label are written in XML, and have the same base file name, they are distinguished by the file name extensions ".sxml" for StationXML and ".xml" for the PDS4 label.

5.2   Document Product Formats

Documents in this archive are provided as PDF/A (https://www.pdfa.org/publication/iso-19005-pdfa/) or as plain ASCII text if no special formatting is required. Figures that accompany documents may be embedded in the PDF/A files or provided as separate TIFF, GIF, JPEG, or PNG files.

5.3   PDS Labels

Each SEIS product is accompanied by a PDS4 label. PDS4 labels are ASCII text files written in the eXtensible Markup Language (XML). Product labels are detached from the files they describe (with the exception of the Product_Bundle label). There is one label for every product. A PDS4 label file usually has the same name as the data product it describes, but always with the extension ".xml".

For the InSight mission, the structure and content of PDS labels will conform to the PDS master schema and schematron based upon the PDS Information Model [3]. By use of an XML editor the

schema and schematron may be used to validate the structure and content of the product labels. In brief, the schema is the XML model that PDS4 labels must follow, and the schematron is a set of validation rules that are applied to PDS4 labels.

The PDS master schema and schematron documents are produced, managed, and supplied to InSight by the PDS. In addition to these documents, the InSight archive uses the InSight Mission Dictionary, which contains XML schema and schematron files specific to the InSight mission. The InSight Mission Dictionary is produced and managed by the PDS Geosciences Node.

Examples of PDS labels for SEIS data products are shown in Appendix B.

Appendix A   Support Staff and Cognizant Persons

Table 9: Archive Support Staff

SEIS Team		
Name	**Affiliation**	**Email**
Renee Weber	Marshall Space Flight Center	renee.c.weber@nasa.gov
Philippe Lognonné, P.I.	Institut de Physique du Globe de Paris (IPGP)	lognonne@ipgp.fr
Sharon Kedar	Jet Propulsion Laboratory (JPL)	sharon.kedar@jpl.nasa.gov
Taoufik Gabsi	IPGP	gabsi@ipgp.fr
Constanza Pardo	IPGP	pardo@ipgp.fr
Laure Luno	CNES	Laure.Luno@cnes.fr
PDS Geosciences Node		
Name	**Affiliation**	**Email**
Raymond Arvidson, director	Washington University	arvidson@wunder.wustl.edu
Edward Guinness	Washington University	guinness@wustl.edu
Susan Slavney	Washington University	susan.slavney@wustl.edu

Appendix B   Example Data Product Labels

This section provides examples of product labels for the various data types described in this document.

The content of actual SEIS data product labels may vary from these examples.

B.1 Dataless SEED Label

```xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>

<Product_Native xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
            https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd
            http://pds.nasa.gov/pds4/mission/insight/v1
            https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.xsd">

    <Identification_Area>
        <logical_identifier>
          urn:nasa:pds:insight_seis:data_seed:dataless.xb.elyse.2019.042
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>InSight SEIS Dataless SEED File</title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Native</product_class>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2019-03-26</modification_date>
                <version_id>1.0</version_id>
                <description>
                    First release
                </description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Context_Area>
        <Time_Coordinates>
            <start_date_time>2019-02-11T00:00:00Z</start_date_time>
```

```xml
        <stop_date_time>2019-02-11T23:59:59Z</stop_date_time>
    </Time_Coordinates>
    <Investigation_Area>
        <name>Insight</name>
        <type>Mission</type>
        <Internal_Reference>
            <lid_reference>
              urn:nasa:pds:context:investigation:mission.insight
            </lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <name>Insight</name>
        <Observing_System_Component>
            <name>Insight</name>
            <type>Spacecraft</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:instrument_host:spacecraft.insight
                </lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>Seismometer</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:instrument:seis.insight
                </lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Mars</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>
        <insight:Observation_Information>
```

24

```xml
            <insight:release_number>1A</insight:release_number>
            <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>
            <insight:product_type>Dataless-SEED</insight:product_type>
            <insight:start_sol_number>075</insight:start_sol_number>
            <insight:stop_sol_number>076</insight:stop_sol_number>
        </insight:Observation_Information>
        <insight:SEIS_Instrument_Parameters>
            <insight:seis_data_type>metadata</insight:seis_data_type>
            <insight:ASCII_Equivalent>
                <insight:ascii_equivalent_file_name>
                  stationxml.xb.elyse.2019.42.sxml
                </insight:ascii_equivalent_file_name>
                <Internal_Reference>
                  <lidvid_reference>
                urn:nasa:pds:insight_seis:data_table:stationxml.xb.elyse.2019.42::1.0
                  </lidvid_reference>
                  <reference_type>seed_to_ascii</reference_type>
                </Internal_Reference>
            </insight:ASCII_Equivalent>
        </insight:SEIS_Instrument_Parameters>
    </Mission_Area>
</Context_Area>
<Reference_List>
    <Internal_Reference>
        <lid_reference>urn:nasa:pds:insight_seis:document:seis_sis</lid_reference>
        <reference_type>native_to_archival</reference_type>
    </Internal_Reference>
</Reference_List>
<File_Area_Native>
    <File>
        <file_name>dataless.xb.elyse.2019.042.seed</file_name>
        <creation_date_time>2019-02-11T00:00:00</creation_date_time>
    </File>
    <Encoded_Native>
        <name>SEIS Dataless SEED</name>
        <offset unit="byte">0</offset>
        <encoding_standard_id>SEED 2.4</encoding_standard_id>
    </Encoded_Native>
</File_Area_Native>
</Product_Native>
```

B.2 StationXML Label

```xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>

<Product_Ancillary xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
                https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd
                http://pds.nasa.gov/pds4/mission/insight/v1
                https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.xsd">

    <Identification_Area>
        <logical_identifier>
            urn:nasa:pds:insight_seis:data_table:stationxml.xb.elyse.2019.042
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>InSight SEIS StationXML File</title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Ancillary</product_class>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2019-03-26</modification_date>
                <version_id>1.0</version_id>
                <description>
                    First release
                </description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Context_Area>
        <Time_Coordinates>
            <start_date_time>2019-01-29T17:52:45.523Z</start_date_time>
            <stop_date_time>2019-02-12T16:47:28.398Z</stop_date_time>
        </Time_Coordinates>
        <Investigation_Area>
            <name>Insight</name>
            <type>Mission</type>
            <Internal_Reference>
```

```xml
            <lid_reference>
              urn:nasa:pds:context:investigation:mission.insight
            </lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <name>Insight</name>
        <Observing_System_Component>
            <name>Insight</name>
            <type>Spacecraft</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:instrument_host:spacecraft.insight
                </lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>Seismometer</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:instrument:seis.insight
                </lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Mars</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>
        <insight:Observation_Information>
            <insight:release_number>1A</insight:release_number>
            <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>
            <insight:product_type>StationXML</insight:product_type>
            <insight:start_sol_number>075</insight:start_sol_number>
            <insight:stop_sol_number>076</insight:stop_sol_number>
        </insight:Observation_Information>
```

```
            <insight:SEIS_Instrument_Parameters>
                <insight:seis_data_type>metadata</insight:seis_data_type>
                <insight:SEED_Equivalent>
                    <insight:seed_file_name>
                        dataless.xb.elyse.2019.042.seed
                    </insight:seed_file_name>
                    <Internal_Reference>
                        <lidvid_reference>
                      urn:nasa:pds:insight_seis:data_seed:dataless.xb.elyse.2019.042::1.0
                        </lidvid_reference>
                        <reference_type>ascii_to_seed</reference_type>
                    </Internal_Reference>
                </insight:SEED_Equivalent>
            </insight:SEIS_Instrument_Parameters>
        </Mission_Area>
    </Context_Area>
    <Reference_List>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:insight_seis:document:seis_sis</lid_reference>
            <reference_type>ancillary_to_data</reference_type>
        </Internal_Reference>
    </Reference_List>
    <File_Area_Ancillary>
        <File>
            <file_name>stationxml.xb.elyse.2019.042.sxml</file_name>
            <creation_date_time>2018-12-20T00:00:00Z</creation_date_time>
        </File>
        <Stream_Text>
            <name>SEIS StationXML</name>
            <offset unit="byte">0</offset>
            <parsing_standard_id>7-Bit ASCII Text</parsing_standard_id>
            <description>
              See StationXML documentation at http://www.fdsn.org/xml/station/.
            </description>
            <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
        </Stream_Text>
    </File_Area_Ancillary>
</Product_Ancillary>
```

B.3 Mini-SEED Data Label

```xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>

<Product_Native xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
    https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd

    http://pds.nasa.gov/pds4/mission/insight/v1
    https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.xsd">

    <Identification_Area>
        <logical_identifier>
          urn:nasa:pds:insight_seis:data_seed:xb.elyse.00.hhu.2019.042.1
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>InSight SEIS data in MiniSEED format</title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Native</product_class>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2019-03-26</modification_date>
                <version_id>1.0</version_id>
                <description>
                    First release
                </description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Context_Area>
        <Time_Coordinates>
            <start_date_time>2019-02-11T00:33:22.791000Z</start_date_time>
            <stop_date_time>2019-02-11T00:42:32.781000Z</stop_date_time>
        </Time_Coordinates>
        <Investigation_Area>
            <name>Insight</name>
            <type>Mission</type>
```

```xml
        <Internal_Reference>
            <lid_reference>
                urn:nasa:pds:context:investigation:mission.insight
            </lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <name>Insight</name>
        <Observing_System_Component>
            <name>Insight</name>
            <type>Spacecraft</type>
            <Internal_Reference>
                <lid_reference>
                    urn:nasa:pds:context:instrument_host:spacecraft.insight
                </lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>Seismometer</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>
                    urn:nasa:pds:context:instrument:seis.insight
                </lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Mars</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>
        <insight:Observation_Information>
            <insight:release_number>1A</insight:release_number>
            <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>
            <insight:product_type>Mini-SEED</insight:product_type>
            <insight:start_sol_number>075</insight:start_sol_number>
            <insight:stop_sol_number>076</insight:stop_sol_number>
```

```
            </insight:Observation_Information>
            <insight:SEIS_Instrument_Parameters>
                <insight:seis_data_type>waveform</insight:seis_data_type>
                <insight:seis_waveform_type>continuous</insight:seis_waveform_type>
                <insight:Metadata_Location>
                    <insight:metadata_file_name>
                      dataless.xb.elyse.2019.042.seed
                    </insight:metadata_file_name>
                    <Internal_Reference>
                        <lid_reference>
                          urn:nasa:pds:insight_seis:data_seed:dataless.xb.elyse.2019.042
                        </lid_reference>
                        <reference_type>data_to_metadata</reference_type>
                    </Internal_Reference>
                </insight:Metadata_Location>
                <insight:ASCII_Equivalent>
                    <insight:ascii_equivalent_file_name>
                      xb.elyse.00.hhu.2019.042.1.a.csv
                    </insight:ascii_equivalent_file_name>
                    <Internal_Reference>
                        <lidvid_reference>
                  urn:nasa:pds:insight_seis:data_table:xb.elyse.00.hhu.2019.042.1.a::1.0
                        </lidvid_reference>
                        <reference_type>seed_to_ascii</reference_type>
                    </Internal_Reference>
                </insight:ASCII_Equivalent>
                <insight:channel_name>00.HHU</insight:channel_name>
                <insight:signal_name>
                  VBB 1 Velocity High Gain Science mode
                </insight:signal_name>
                <insight:sampling_rate unit="Hz">100</insight:sampling_rate>
                <insight:sample_count>47300</insight:sample_count>
            </insight:SEIS_Instrument_Parameters>
        </Mission_Area>
    </Context_Area>
    <Reference_List>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:insight_seis:document:seis_sis</lid_reference>
            <reference_type>native_to_archival</reference_type>
        </Internal_Reference>
    </Reference_List>
    <File_Area_Native>
        <File>
            <file_name>xb.elyse.00.hhu.2019.042.1.mseed</file_name>
            <creation_date_time>2018-03-13T14:40:00Z</creation_date_time>
```

31

```
        </File>
        <Encoded_Native>
            <name>SEIS Mini-SEED Data</name>
            <offset unit="byte">0</offset>
            <encoding_standard_id>SEED 2.4</encoding_standard_id>
        </Encoded_Native>
    </File_Area_Native>
</Product_Native>
```

B.4 GeoCSV Label

```xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
    href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>

<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
               https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd
               http://pds.nasa.gov/pds4/mission/insight/v1
               https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1850.xsd">

    <Identification_Area>
        <logical_identifier>
          urn:nasa:pds:insight_seis:data_table:xb.elyse.00.hhu.2019.042.1.a
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>InSight SEIS raw data from 2017-100 in GeoCSV format</title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2019-03-26</modification_date>
                <version_id>1.0</version_id>
                <description>
                    First release
                </description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Observation_Area>
        <Time_Coordinates>
            <start_date_time>2019-02-11T00:33:22.791000Z</start_date_time>
            <stop_date_time>2019-02-11T00:42:32.781000Z</stop_date_time>
        </Time_Coordinates>
        <Investigation_Area>
            <name>Insight</name>
            <type>Mission</type>
            <Internal_Reference>
```

```xml
            <lid_reference>
              urn:nasa:pds:context:investigation:mission.insight
            </lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <name>Insight</name>
        <Observing_System_Component>
            <name>Insight</name>
            <type>Spacecraft</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:instrument_host:spacecraft.insight
                </lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>Seismometer</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>
                    urn:nasa:pds:context:instrument:seis.insight
                </lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Mars</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>
        <insight:Observation_Information>
            <insight:release_number>1A</insight:release_number>
            <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>
            <insight:product_type>GeoCSV</insight:product_type>
            <insight:start_sol_number>075</insight:start_sol_number>
            <insight:stop_sol_number>076</insight:stop_sol_number>
        </insight:Observation_Information>
```

```
            <insight:SEIS_Instrument_Parameters>
                <insight:seis_data_type>waveform</insight:seis_data_type>
                <insight:seis_waveform_type>continuous</insight:seis_waveform_type>
                <insight:Metadata_Location>
                    <insight:metadata_file_name>
                      stationxml.xb.elyse.2019.042.sxml
                    </insight:metadata_file_name>
                    <Internal_Reference>
                        <lid_reference>
                        urn:nasa:pds:insight_seis:data_table:stationxml.xb.elyse.2019.042
                        </lid_reference>
                        <reference_type>data_to_metadata</reference_type>
                    </Internal_Reference>
                </insight:Metadata_Location>
                <insight:SEED_Equivalent>
                    <insight:seed_file_name>
                      xb.elyse.00.hhu.2019.042.1.mseed
                    </insight:seed_file_name>
                    <Internal_Reference>
                        <lidvid_reference>
                      urn:nasa:pds:insight_seis:data_seed:xb.elyse.00.hhu.2019.042.1::1.0
                        </lidvid_reference>
                        <reference_type>ascii_to_seed</reference_type>
                    </Internal_Reference>
                </insight:SEED_Equivalent>
                <insight:channel_name>00.HHU</insight:channel_name>
                <insight:signal_name>
                  VBB 1 Velocity High Gain Science mode
                </insight:signal_name>
                <insight:sampling_rate unit="Hz">100</insight:sampling_rate>
                <insight:sample_count>47300</insight:sample_count>
            </insight:SEIS_Instrument_Parameters>
        </Mission_Area>
    </Observation_Area>
    <Reference_List>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:insight_seis:document:seis_sis</lid_reference>
            <reference_type>data_to_document</reference_type>
        </Internal_Reference>
    </Reference_List>
    <File_Area_Observational>
        <File>
            <file_name>xb.elyse.00.hhu.2019.042.1.a.csv</file_name>
            <creation_date_time>2018-03-13T14:40:00Z</creation_date_time>
        </File>
```

```xml
<Header>
    <name>Table 1 Comments </name>
    <offset unit="byte">0</offset>
    <object_length unit="byte">458</object_length>
    <parsing_standard_id>7-Bit ASCII Text</parsing_standard_id>
    <description>
      See GeoCSV documentation at http://geows.ds.iris.edu/documents/GeoCSV.pdf.
    </description>
</Header>
<Header>
    <name>Table 1 Column Headings</name>
    <offset unit="byte">458</offset>
    <object_length unit="byte">14</object_length>
    <parsing_standard_id>PDS DSV 1</parsing_standard_id>
    <description>Comma-separated names of columns in the data table</description>
</Header>
<Table_Delimited>
    <name>Table 1 in SEIS GeoCSV File xb.elyse.00.hhu.2019.042.1.a.csv</name>
    <offset unit="byte">472</offset>
    <parsing_standard_id>PDS DSV 1</parsing_standard_id>
    <records>23100</records>
    <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
    <field_delimiter>Comma</field_delimiter>
    <Record_Delimited>
        <fields>2</fields>
        <groups>0</groups>
        <Field_Delimited>
            <name>Time</name>
            <field_number>1</field_number>
            <data_type>ASCII_Date_Time_YMD_UTC</data_type>
        </Field_Delimited>
        <Field_Delimited>
            <name>Sample</name>
            <field_number>2</field_number>
            <data_type>ASCII_Integer</data_type>
            <description>
              See Table Comments header for values of scale_factor and
              scale_units. Sample value divided by scale_factor equals physical
              value in scale_units.
            </description>
        </Field_Delimited>
    </Record_Delimited>
</Table_Delimited>
<Header>
    <name>Table 2 Comments</name>
```

```xml
                <offset unit="byte">839600</offset>
                <object_length unit="byte">458</object_length>
                <parsing_standard_id>7-Bit ASCII Text</parsing_standard_id>
                <description>
                   See GeoCSV documentation at http://geows.ds.iris.edu/documents/GeoCSV.pdf.
                </description>
            </Header>
            <Header>
                <name>Table 2 Column Headings</name>
                <offset unit="byte">840058</offset>
                <object_length unit="byte">14</object_length>
                <parsing_standard_id>PDS DSV 1</parsing_standard_id>
                <description>Comma-separated names of columns in the data table</description>
            </Header>
            <Table_Delimited>
                <name>Table 2 in SEIS GeoCSV File xb.elyse.00.hhu.2019.042.1.a.csv</name>
                <offset unit="byte">840072</offset>
                <parsing_standard_id>PDS DSV 1</parsing_standard_id>
                <records>24200</records>
                <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
                <field_delimiter>Comma</field_delimiter>
                <Record_Delimited>
                    <fields>2</fields>
                    <groups>0</groups>
                    <Field_Delimited>
                        <name>Time</name>
                        <field_number>1</field_number>
                        <data_type>ASCII_Date_Time_YMD_UTC</data_type>
                    </Field_Delimited>
                    <Field_Delimited>
                        <name>Sample</name>
                        <field_number>2</field_number>
                        <data_type>ASCII_Integer</data_type>
                        <description>
                           See Table Comments header for values of scale_factor and
                           scale_units. Sample value divided by scale_factor equals physical
                           value in scale_units.
                        </description>
                    </Field_Delimited>
                </Record_Delimited>
            </Table_Delimited>
        </File_Area_Observational>
</Product_Observational>
```