DDE STANDARD

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Geoscience Information Metadata

Deep-time Digital Earth Program of The International Union of Geological Sciences

CONTENTS

Foreword

Geoscience data acquired in the present is the key to understanding the geological past. The Big Science Program Deep-time Digital Earth (DDE) of the International Union of Geological Sciences (IUGS) aims to transform Earth science by harmonizing global digital Earth data and sharing global geoscience knowledge to help understand evolution of life, evolution of matter, evolution of geography, evolution of climate, and find solutions to contemporary problems and challenges like climate change, ecological renewal, water supply, and energy transformation.

Geoscience data standards for implementing the DDE program are essential for data, service and knowledge findable, accessible, interoperable and reusable[1] across globally distributed multi-disciplinary heterogeneous geoscience databases and providing access to efficient digital interoperable cross disciplinary geoscience standards, knowledge systems, tools and methodologies in convenient forms for scientists, public and industry, for better insights into the distribution and value of earth's resources and materials.

An efficient practical metadata standard based on existing world-wide implemented International Organization (ISO) and Open Geospatial Consortium(OGC) standards and web application technologies is of essential importance to DDE data, service and knowledge findable, and helpful to fairness. DDE Geoscience Information Metadata Standard is thus issued as a core metadata standard for DDE program. It sets out the requirements for the creation, sharing and maintenance of metadata of geoscience data resources and services of various themes of the DDE. It can be extended for different geoscience related disciplines and domains to foster findability and accessibility of geosciences data, service and knowledge through the web and the DDE platform, as well.

Document history

This standard was drafted and revised by the following experts and scientists both from and outside the DDE Standards Task Group (DDE-STG) in 2021, 2022 and 2023 with the collaboration of DDE Data Science Group, DDE Knowledge Group and other DDE Working Groups and Task Groups.

The initial version of this DDE metadata standard was drafted and proposed in Aug.2021 by Prof Dr Zhang Minghua, Dr Liu Rongmei, Dr Ren Wei, Dr Zhang Sheng, Dr Yu Hailong and Prof Jiang Zuoqin from China.

The first revision, update 1, of this standard document was made by Dr Tim Duffy and Edd Lewis from British Geological Survey(BGS), Dr Mark Rattenbury form GNS Science New Zealand, Gabriel Asato from Argentina Geological Survey (SEGEMAR), Francisco Valdir from Brazil Geological Survey (CPRM), Afraz Shah from University of Brunei, Prof Ma Chao from Chengdu University of Technology, Prof Dr Wang Juanle, Dr. Li Kai and Fan Haiming form the Institute of Geographic Sciences and Natural Resources Research, China Academy of Science, and prof Li Xianhua from the institute of geology and geophysics, China Academy of Science, Dr Alena Rybkina from geophysical center, Russian Academy of Science in Sep and Oct. 2021.

The second revision, the update2 of the draft version of this standard was then made by Dr Stephen M. Richard from US Geoscience Information (USGIN) Foundation in Nov. 2021, and following edits by Dr Yu Hailong, Dr. Federica Foglini and Dr. Caterina Bergami from ISMAR-CNR (Institute of Marine Sciences, National Research Council of Italy), and Prof Hu Xiumian and Dr Xu Yiwei form Nanjing university in Sep. and Oct. 2022.

Further revision was made as the version update3 by Jiang Zuoqin, Edd Lewis, and Prof Bai Yuqi from Tsinghua University till May, 2023, and edited by Zhang Minghua and Yu Hailong in June,2023. Final updates to this version following the team meeting in August 2023, were made by S.M. Richard, Zhang Minghua, Yu Hailong and Caterina Bergami.

Final edition of this standards document was completed on 5 November by Yu Hailong, Zhang Minghua and Stephen Richard following the finalization meeting on 31Aug and final discussion on 24 Oct of the team and relevant DDE working groups and task groups.

XSD file of the standard is prepared by Dr Yu Hailong and Dr. S. M. Richard.

This standard is released by DDE.

Geosciences Information Metadata

1.Scope

This standard defines the information content and XML serialization for metadata descriptions of geoscience information resources supporting the DDE program. It provides information about the identification, quality, contents, spatial reference, lineage, and distribution of the data. This standard applies to the description of geoscience data resources including a variety of geoscientific disciplinary spatial and non-spatial data, to ensure they are Findable, Accessible and with sufficient documentation to make them Reusable. The scope of DDE Geosciences Information metadata is defined to include the resource types listed in the resourceType codelist. See the *ResourceTypeCode <<CodeList>>* in Annex A. Conformance with this standard will ensure that DDE metadata are interoperable, facilitating metadata searching, harvesting and sharing.

2.Compatibility

This standard is developed with reference to ISO19115-1:2014E[2,3] as the core metadata information model to meet the needs of DDE program development, particularly the demands from DDE Working Groups and Task Groups. The metadata content is intended to be compatible with metadata standards implemented by international initiatives and regional programs like OneGeology Metadata Standard[4], INSPIRE Metadata Standard[5], Dublin Core metadata element set (ISO15836:2003(E)) [6,7], CCOP Geoinformation Metadata Standard[8], Schema.org[8a], and the W3C Data Catalog (DCAT)[8b]. DDE metadata content includes all core metadata elements of ISO19115:2014E. Many element and entity names from ISO19115:2014E have been used to make correspondence explicit, but entity content and element value domains have been simplified in most cases..

Content related to geosciences has been extended in several ways:

The topic category codelist defined in ISO19115-1:2014(E) MD_TopicCategoryCode <<Enumeration>> is extended by adding 1 top level concept 'data science' and 41 second level concepts refining the 'geoscientificInformation' category to cover all the themes and disciplinaries of DDE. See listing at TopicCategoryCode <<CodeList>>

Data acquisition observation methods are specified using a new codelist, which contains concepts for commonly used geosciences data acquisition methods. These methods are mostly compatible with CGI's Observation Method Vocabulary (http://resource.geosciml.org/classifier/cgi/featureobservationmethod). The codelist is defined in AcquisitionCode <<CodeList>>

A code list for service types is defined in ServiceTypeCode <<Codelist>> to populate the serviceType property.

The identifiers for DDE data resources are specified using a DOI, DDE code, or other character string, using the pattern defined by the ISO19115-1 MD_Identifier that enables specifying a codespace, and identifier authority in addition to the actual identifier code. A DOI is a unique and persistent (never-changing) string

assigned to online articles, books, and other works[9]. These identifiers are maintained by the DOI Foundation (https://www.doi.org/). This specification defines an identifier syntax for DDE identifier code strings for use if other identifiers are not available.

Calendar Date and DateTime are serialized using syntax based on ISO8601 (see Calendar Date and Time).

Geological ages are reported using named time intervals from the International Commission on Stratigraphy International Chronostratigraphic Chart (https://stratigraphy.org/chart).

This specification uses plain text and Unified Modeling Language (UML) for presentation purposes.

3. Normative references

No documents are normatively referenced in this specification

4. Terms and definitions

For the purpose of this document, the following terms and definitions apply.

4.1 attribute

named property of an entity
Note: Describes a geometrical, topological, thematic, or other characteristic of an entity.
[SOURCE: ISO19115-2:2019(E),3.1]
Note: as used in this specification, attribute refers to a property independent of the entity to which it applies. A metadata element is an attribute in the context of particular metadata entity or entities, with a defined cardinality and value type. For example, 'responsibility' would be an attribute, and 'metadataResponsibleParty', 'distributionResponsibleParty' and 'resourceResponsibleParty' would be elements that implement that attribute.

4.2 coverage

feature that acts as a function to return values from its range for any direct position within its spatial, temporal or spatiotemporal domain.
EXAMPLE Raster image (4.8), polygon overlay, or digital elevation matrix.
[SOURCE: ISO 19115-2:2019,3.4]

4.3 data

data is a collection of discrete values that convey information, describing quantity, quality, fact, statistics, other basic units of meaning, or simply sequences of symbols that may be further interpreted.
[SOURCE: Wikipedia, 2022 (https://en.wikipedia.org/wiki/Data)]

4.4 dataset

identifiable collection of data
Note: a dataset can either be a whole database or part of a database. Theoretically, a dataset may be as small as a single feature or feature attribute contained within a larger dataset. A hardcopy map or chart can be considered a dataset.
[SOURCE: ISO19115-1:2014(E), 4.3]

4.5 dataset series

collection of datasets sharing common characteristics
[SOURCE: ISO19115-1:2014(E),4.4]

4.6 feature

abstraction of real world phenomena
Note: example- fault is a feature in geology.
[SOURCE: ISO19115-1:2014(E),4.5]

4.7 grid

network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in an algorithmic way
Note 1 to entry: The curves partition a space into grid cells.
[SOURCE: ISO 19115-2:2019, 3.13]

4.8 image

gridded coverage (4.2) whose attribute values are a numerical representation of a physical parameter.
Note 1 to entry: The physical parameters are the result of measurement by a sensor or a prediction from a model.
[SOURCE: ISO 19115-2:2019, 3.18]

4.9 imagery

representation of phenomena as images (4.8) produced by electronic and/or optical techniques.
Note 1 to entry: In this document, it is assumed that the objects and phenomena have been sensed or detected by radar, cameras, photometers, and infrared and multispectral scanners, or similar devices.
[SOURCE: ISO 19101-2:2008, 4.14]

4.10 metadata

information about a resource, or data about data. It provides information about the resource, including its content, extent, quality, status, management, owner, and distribution.
[SOURCE: ISO19115-1:2014(E),4.10; ISO19115:2003(E); CCOP S01:2010]

4.11 metadata element

discrete unit of metadata.
Note 1 Metadata elements are unique within a metadata entity definition.
Note 2 A metadata entity contains a set of metadata elements that implement the attributes defined in the content model for that entity.
[SOURCE: ISO19115-1:2014(E),4.11]
Note: As used in this specification, a metadata element is an attribute in the context of a particular metadata entity, with a defined cardinality and value type. An attribute is a property independent of the entity to which it applies.

4.12 metadata entity

set of metadata elements describing the same aspect of a resource
[SOURCE: ISO19115-1:2014(E),4.12]

4.13 resource

identifiable asset or means that fulfills a requirement
Note 1 for example: dataset, dataset series, service, document, initiative, software, person or organization.
[SOURCE: ISO19115-1:2014(E),4.17]

4.14 service

distinct part of the functionality that is provided by an entity through interfaces

Note 1 The functionality of the entity is characterized by a set of operations.
[SOURCE: ISO 19119:2016,4.1.12]
Note 2 A service is a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description.

5.Metadata structure and content

5.1 Metadata structure

DDE Geosciences information metadata comprises six major topics: Metadata information, Resource identification information, Service identification information, Spatial representation information, Imagery information, and Distribution information, each with a root metadata entity, and a set of metadata elements. There are six metadata entities used as the value for metadata elements in the model: Responsibility, Identifier, Online Resource, Geographic Extent, Temporal Extent, and Date. Strings, dates and numbers provide the values for other metadata elements. There are 88 total elements, 22 of which are mandatory (the exact value depends on the resource type described), and 14 code lists. 6 code lists are adopted from ISO-19115-3; 3 of the code lists are maintained by outside authorities (IETF, ISO), and 5 codelists are new for this specification. Tables 1-13 define the entities and elements. Code lists are documented in Annex A. Annex B provides an XML schema implementing the content items defined in this specification. Figure 1 diagrams the structure of the DDE metadata using UML notation.

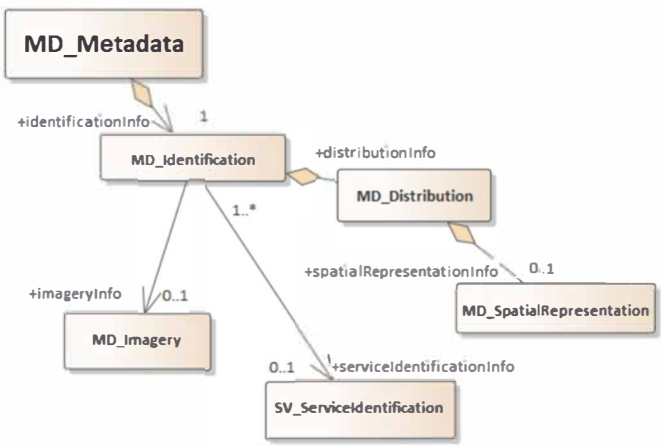


Figure 1. The structure diagram of DDE Geosciences Information Metadata

5.2Metadata core entities

5.2.1 Metadata information

The MD_Metadata entity is the mandatory root entity for a metadata object. The UML diagram in Figure 2 depicts the entities, elements, roles and codelists directly associated with the MD_Metadata entity. The MD_Metadata entity contains 4 elements that specify information about the metadata record itself, an optional element that links to a browse graphic for the described resource, and a resourceType element that specifies the kind of resource the metadata object documents. Roles link the MD_Metadata entity to a resource

identification entity and one or more distribution entities. The resource identification entity contains detailed information about the resource that is the subject of the metadata record, and the distribution entities specify how the resource content can be accessed. Entities specified in the following List 1, are linked as element values from MD_Metadata. Table 1 in the dictionary provides more detailed information about the elements.

List 1. Top level entities and elements contained in MD_Metadata element.

Mandatory entities:

MD_Identification
CI_Responsibility
CI_Date
MD_Identifier

Mandatory elements:

metadataIdentifier
metadataStandardName
metadataDate
metadataResponsibility

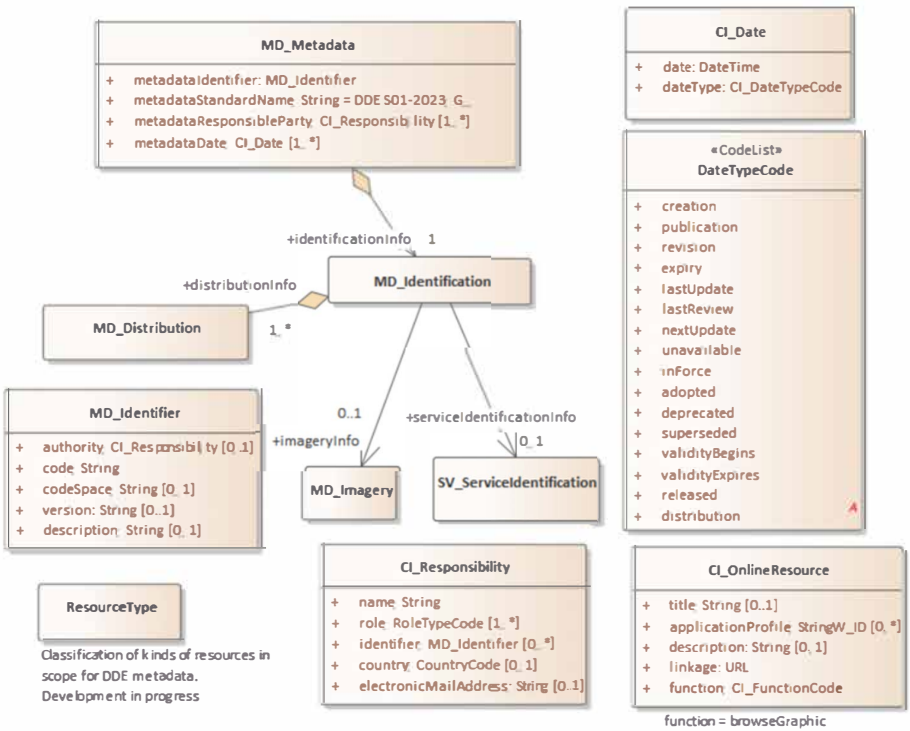


Figure 2. Metadata information classes. See ResourceTypeCode <<CodeList>> for listing of resource type values.

5.2.2 Resource identification information

The MD_Identification entity provides information to identify and describe an information resource. The mandatory MD_Identification entity contains a mandatory MD_Constraints entity, 23 elements, and two conditional entities, MD_Imagery and SV_ServiceIdentification, for metadata describing imagery data or services. The MD_Constraints must minimally indicate what restrictions there are for access and usage of the described resource. The content is shown in List 2, defined in Table 2 in the dictionary, and represented in UML in Figure 3.

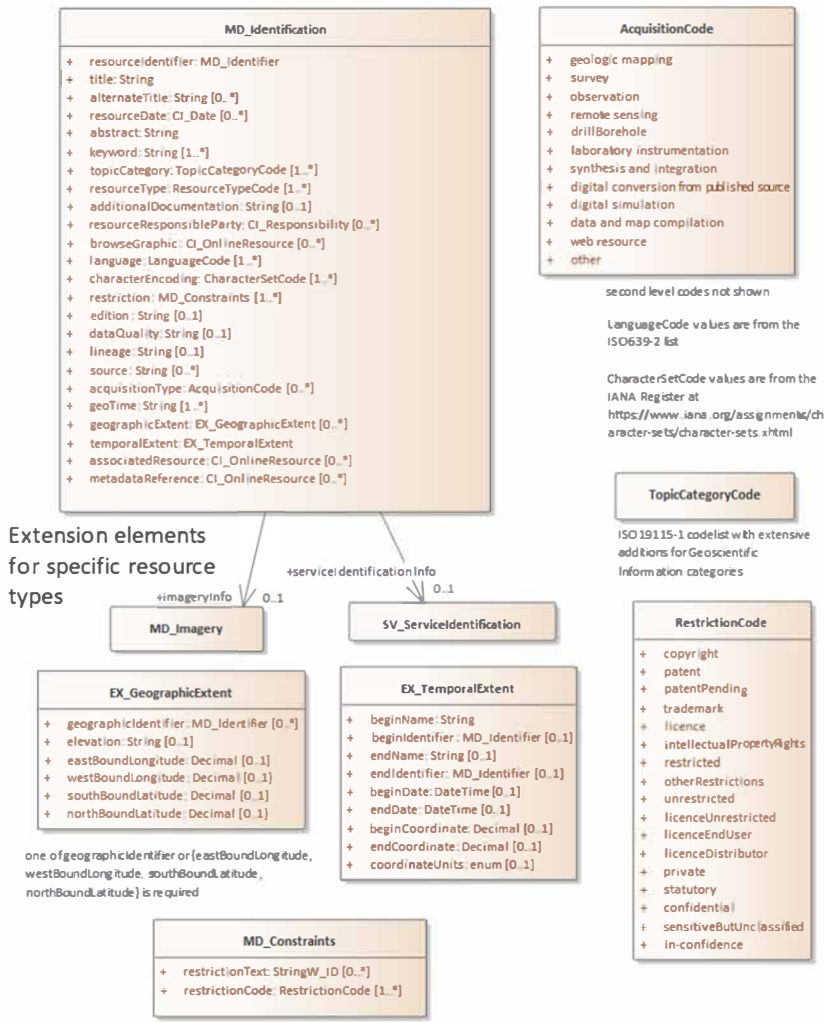


Figure 3. Identification information entities, elements and codelists.

List 2. Entities and elements in MD_Identification

Mandatory entity:

MD_Identification

MD_Constraints

Conditional entity:

MD_Imagery

SV_ServiceIdentification

Mandatory elements:

resourceIdentifier

title

abstract

keyword

topicCategory

resourceType

language

characterEncoding

restrictionCode

geoTime

Conditional elements:

dataQuality

lineage

source

acquisitionType

associatedResource

metadataReference

Optional elements:

geographicExtent

temporalExtent

alternateTitle

resourceDate

edition

additionalDocumentation

restrictionText

5.2.3 Service identification information

Service identification information is a conditional entity that provides a description of the functionality of a service. The basic identification information for the service is included in the identificationInfo/ MD_Identification element in the metadata record. The functionality of the service is represented by SV_ServiceIdentification and consists of one conditional entity, MD_Identifier, and the 6 elements, shown in List 3, and defined in Table 3 and represented in UML in Figure 4. If there are other resources (not the data provided by the service) required by the service (coupledResource), they should be linked using the MD_Identification/ associatedResource element. The operatedDataset/MD_Identifier entity specifies datasets that the service can provide access to or uses in its processing.

List 3. Entities and elements in SV_ServiceIdentification

Conditional entity:

MD_Identifier

Mandatory elements:

serviceType

Optional element:

accessProperties

containsOperations

endpointDescription

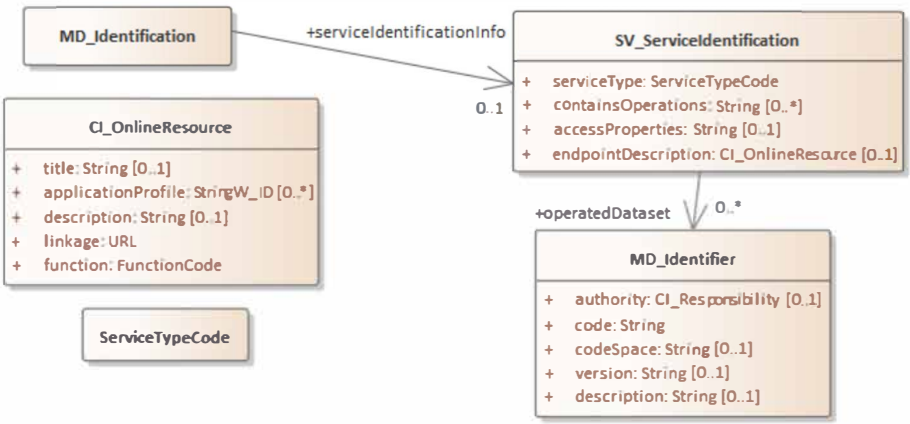


Figure 4. SV_ServiceIdentification entities, elements and codelist.

5.2.4 Imagery information

Imagery information is a conditional entity required when the resourceType is image or one of the subtypes of image. The entity provides additional information specific to raster or image data. It consists of the 9 elements in List 4, defined in Table 4 and represented in UML in Figure 5 with relations and relevant codelists..

List 4. Elements contained in MD_Imagery

Optional elements:

sensor

platform

equipment

collector

startTime

endTime

signalGenerator

processedLevel

wavelength

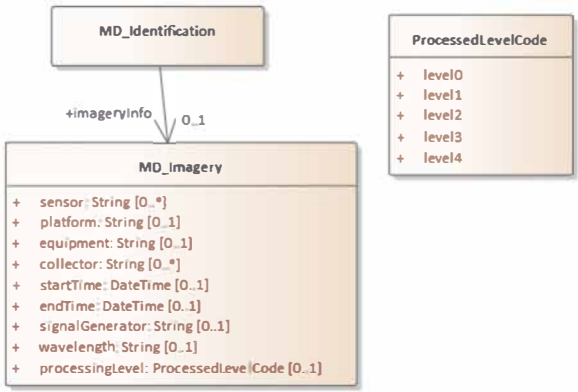


Figure 5. Imagery entity, elements and codelist

5.2.5 Distribution information

Distribution information is a required entity that describes format and options for obtaining the resource, and contact information for the distributor. It's represented by MD_Distribution and consists of the 4 elements shown in List 5, defined in Table 5, and represented in UML in Figure 6 with relations and relevant codelists.

List 5. Elements contained in MD_Distribution

Mandatory elements:

onlineResource

distributionFormat

Optional element:

distributionResponsibleParty

spatialRepresentationInfo

Figure 6. Distribution and Spatial Representation entities, elements and codelists.

5.2.6 Spatial representation information

Spatial representation information is a conditional entity that is required to describe the representation of location in a spatial dataset, including geographical location and spatial resolution and reference system. This entity is represented by MD_SpatialRepresentation and is an aggregation of the following 4 elements shown in List 6, defined in Table 6 and denoted in Figure 6 for the elements, relations and relevant codelists.

List 6. Entities and elements in MD_SpatialRepresentation

Mandatory element:

spatialResolution
spatialRepresentationType
referenceSystemType
referenceSystemIdentifier

5.3Metadata element value entities

5.3.1 Dates

Date values are used in two contexts for DDE metadata. Date values are used to specify calendar dates with optional clock times for events in the production, review, publication and revision of a resource. Dates are also used to specify the time interval (temporal extent) related to the information content of the resource. This second use might specify an interval with a begin and end calendar date or date and time, might specify an

interval using begin and end named time intervals from the geologic time scale, or might specify the interval using numeric time coordinates in thousands, millions or billion years before present.

Calendar Date and Time

Calendar dates are specified using strings based on ISO 8601 The precision of the date can be defined by showing a combination of century plus year plus month plus day, e.g. YY (century), YYYY (year), YYYY-MM (year-month), YYYY-MM-DD (year, month and day).

A time is specified by appending an hour, minute and second to a year, month and day string, based on ISO 8601. The DateTime definition allows the less precise values. For example YYYY-MM-DDThh (year, month, day, hour), YYYY-MM-DDThh:mm (year, month, day, hour, minute), YYYY-MM-DDThh:mm:ss.d (year, month, day, hour, minute, second and decimals of seconds). The time zone should also be added, e.g. YYYY-M-DDThh:mm:ss.d+hh:mm. Inclusion of the punctuation in the date or dateTime strings is critical to enabling parsing of the time position values.

Named Geological Time Intervals

Gives values for geological time period or age in smallest resolvable geologic time scale unit, from the International Stratigraphic Chart released and updated by International Commission on Stratigraphy of the International Union of Geological Sciences. For example, Upper Jurassic, Holocene, etc. Use the International Stratigraphic Chart (https://stratigraphy.org/chart).

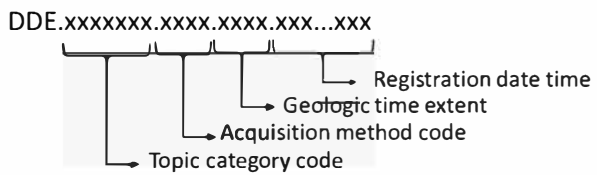
Numeric temporal positions

Geologists typically report a temporal location as a temporal position with coordinates in thousand, million or billion (10^9) years (ka, Ma or Ga) before present. Present is typically take as the year 1950 CE. Values should be reported as decimal numbers for interoperability.

EXAMPLE 201.3 Ma (the age is 201.3 million years). The time point.

5.3.2 DDE Identifier convention

Identifiers for registered DDE data resources that can be generated automatically using the following pattern.



For the Topic Category and Acquisition method, a 's' prefix indicates a single code value; 'm' prefix indicates multiple code value. Geologic time extent should be a named era from the DDE geologic time scale most applicable to the identified resource. The registration date and time is the ISO8601 DateTime with punctuation removed; registrations in the same second are numbered sequentially with the last three digits(in red in the example). Spaces (if present) are removed from all code values, and all characters are lower case. Example:

DDE.stratigraphy.*outcropobservation*.jurassic.20210518114948001

5.3.3 String with identifier

The XML implementation adds a type named 'StringW_ID', analogous to the ISO19115-1 'Anchor' type. This is a string value that can have an XML attribute URI. This enables a labeled link to a named resource, where the string value is the name of the resource, and the URI is a resolvable identifier for that resource.

5.3.4 Online resource information

Online resource information is a common class represented by CI_OnlineResource. This entity contains 5 elements shown in List 7, 2 of which are mandatory. Elements are described in Table 10 and depicted in Figure 7.

List 7. Elements contained in CI_OnlineResource

Mandatory element:

linkage

function

Optional elements:

title

applicationProfile

description

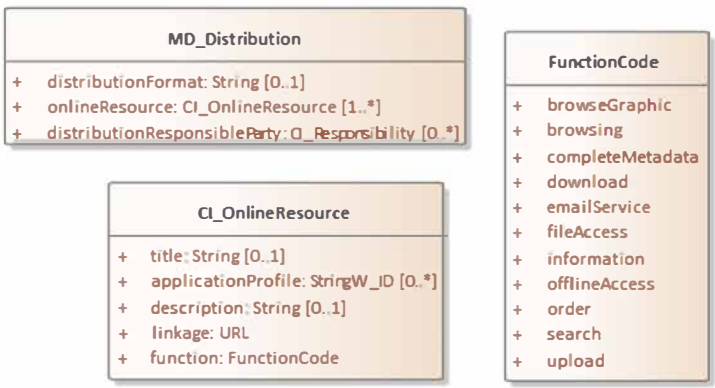


Figure 7. CI_OnlineResource entity, elements and codelist.

5.3.5 Responsible party information

Responsible party information is a common class represented by CI_Responsibility, which describes the information about the party and their roles. The entity CI_Responsibility consists of the 4 elements in List 8, and defined in Table 11 in the dictionary, and represented in UML in Figure 8 with relations and relevant codelists.

List 8. Elements contained in CI_Responsibility

Mandatory element:

name

roleType

identifier

Optional elements:

country

electronicMailAddress

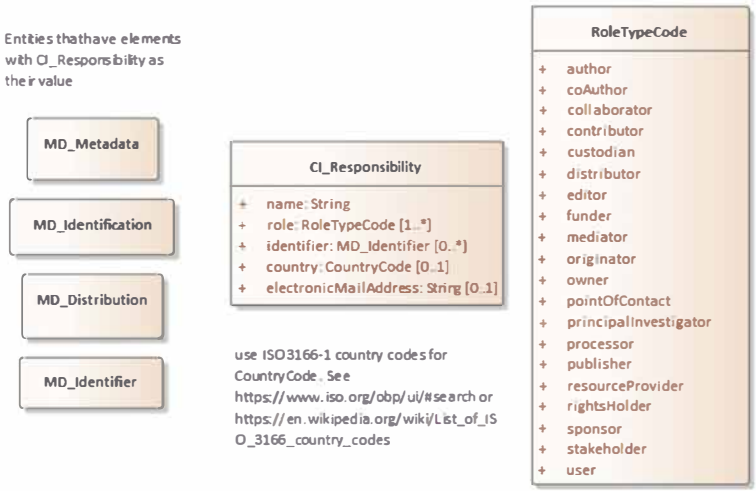


Figure 8. CI_Responsibility entity, elements, and codeList

5.3.6 Extent

Extent entities specify spatial or temporal location(s) related to the described resource. There are separate entities for geographic extent and temporal extent, depicted in Figure 9.

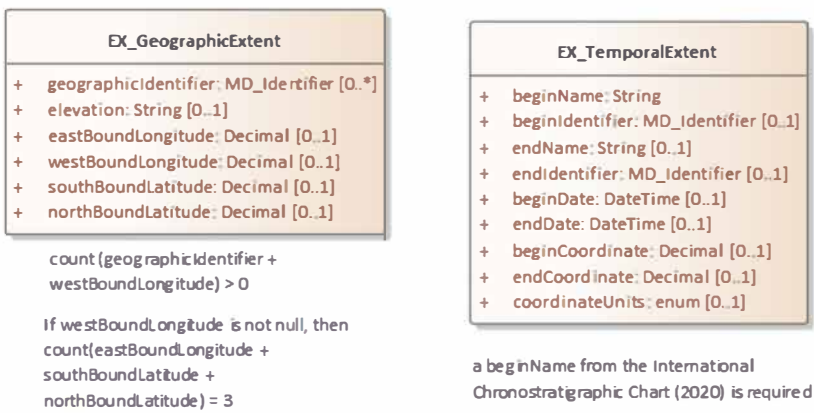


Figure 9. Geographic and Temporal Extent entities

5.3.6.1 Geospatial Extent

Geographic extent information is a common class represented by EX_GeographicExtent, which describes the information about the geospatial location of the resource content. An extent can be specified with an identifier for the location, or with a bounding box specified by the latitude and longitude coordinates of the southwest and northeast corners of the box. For interoperability, coordinates must be specified in decimal degrees using WGS84 (EPSG 4326) coordinate reference system. At least one of geographicIdentifier or the bounding box corner coordinates must be specified. This entity consists of the 6 elements in List 9, and defined in Table 8 in the dictionary, and represented in UML in Figure 9.

List 9. Elements contained in EX_GeographicExtent

Mandatory element:

- geographicIdentifier
- eastBoundLongitude
- westBoundLongitude
- southBoundLatitude
- northBoundLatitude

Optional element

- Elevation

5.3.6.2 Temporal extent

The EX_temporalExtent entity provides interoperable information about the time interval related to the resource content. The interval has a beginning and an ending. The temporal positions can be specified with a calendar date or dateTime, a named geologic time interval from the ICS Chronostratigraphic Chart, or a numeric time coordinate in thousand, million or billion years before present. If the best temporal extent is a single time position, only the beginning value should be provided. If the beginning is specified with a calendar date or dateTime, then the end must also be a calendar date or dateTime. A beginName from the International Chronostratigraphic Chart (2020) is required. This entity consists of the 9 elements in List 10, defined in Table 12 in the dictionary, and represented in UML in Figure 9.

List 10. Elements contained in EX_TemporalExtent

Mandatory element:

- beginName

Optional element

- beginIdentifier
- endName
- endIdentifier
- beginDate
- endDate
- beginCoordinate
- endCoordinate
- coordinateUnits

5.4Data dictionary

This data dictionary describes the details of Geosciences Information metadata entities, elements and classes with names, short names, definitions, obligation/condition, maximum occurrence, types and domain. The dictionary contains 12 tables together with 14 codelists in Annex A. The column headings in the data dictionary tables are described in the following sections.

5.4.1 Explanation

5.4.1.1 Name/role name

A label assigned to a metadata entity(class) or to a metadata element. Metadata entity names start with an upper case letter. Spaces do not appear in a metadata entity or element names. Instead, multiple words are concatenated, with each new subword starting with a capital letter (upper camel case, example: XnnnYnnnn). Use of the two letter prefixes (e.g. MD_, CI_, EX_) are used to emphasize connection to elements in the ISO19115-1 model, recognizing that implementation of these entities in DDE metadata is simplified; although the name of the entity might match the name of an ISO19115-1 entity, the DDE entities are in the DDE metadata namespace and are not the same.

Metadata entity names are unique within the entire data dictionary of this DDE Metadata Standard. Metadata element names are unique within a metadata entity, not the entire data dictionary of this standard.

Metadata elements start with a lower case letter, i.e. lower camel case.

Metadata element names are made unique, within an application, by the combination of the metadata entity and metadata element names (example: MD_Identifier/description).

Role names are used to identify metadata elements shown as associations in the UML diagrams and are preceded by "Role name:" in the dictionary tables. Depiction as an element contained in an entity 'box' or as an association connecting entities is a matter of convenience and clarity in constructing the UML diagrams; the implementation in XML is the same.

5.4.1.2 Definition

Definition provides a description of a metadata entity or metadata element.

5.4.1.3 Obligation/Condition

This is a descriptor indicating whether a metadata entity or metadata element shall always be documented in the metadata or sometimes be documented (i.e. contain value(s)). This descriptor may have the following values: M (mandatory), C (conditional), or O (optional).

Mandatory (M)

This value indicates a metadata entity or metadata element that must always be documented.

Conditional (C)

This value indicates a metadata entity or element that must be documented if a particular condition is met.

Optional (O)

This value indicates a metadata entity or element that may or may not be documented. If an optional entity is not used, all the elements contained within that entity (including mandatory elements) will also not be used. Optional entities may have mandatory elements; those elements only become mandatory if the optional entity is used.

5.4.1.4 Maximum occurrence

This descriptor specifies the maximum number of instances the metadata entity or the metadata element may have. Single occurrence is shown by "1"; repeating occurrences are represented by "N".

5.4.1.5 Data type

This descriptor specifies the kinds of values that may be used to specify a metadata element. For example, integer, real, string, DateTime, and Boolean.

5.4.1.6 Domain

The domain specifies the values allowed, such as entity or class name, codelist name, data type names, or the use of free text. "Free text" indicates that no restrictions are placed on the content of the field.

5.4.2 Tables

Table 1 – Metadata information (MD_Metadata)

Root entity for a metadata object describing an information resource in scope of DDE Metadata

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
1	metadataIdentifier	unique Identifier for this metadata record	M	1	Class	MD_ Identifier (Table 9)
2	metadataStandardName	Name of the metadata standard (including profile name or version) used Required: "DDE S01-2023: Geosciences Information Metadata"	M	1	CharacterString	Free Text/default: DDE S01-2021: Geosciences Information Metadata
3	metadataResponsibleParty	information about the party who is responsible for creation or maintenance of the metadata.	M	N	Class	CI_Responsibility (Table 11)
4	metadataDate	date(s) associated with the metadata, update date must be provided; others can also be provided.	M	N	Class	CI_Date (Table 7)
5	Role name: identificationInfo	Identifier for the resource described by this metadata record	M	1	Class	MD_Identification (Table 2)

Table 1. MD_Metadata elements

Table 2 – Resource identification information (MD_Identification)

The MD_Identification entity provides basic information required to identify a resource. This is mandatory as the value of the identificationInfo element.

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
6	resourceIdentifier	Unique identifier information of the data resource	C/if unique identifier code exists	1	Class	MD_ Identifier (Table 9)
7	title	name by which the dataset or resource is known	M	1	CharacterString	Free text
8	alternateTitle	short name or other language name by which the dataset or resource information is known EXAMPLE "DDE" or in Chinese "深时数字地球@cn" as an alternative title for "Deep-time Digital Earth"	O	N	CharacterString	Free text
9	resourceDate	reference date for the dataset or resource	O	N	Class	CI_Date (Table 7)
10	abstract	brief narrative summary of the resource	M	1	CharacterString	Free text. At least 100 words

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
11	keyword	commonly used word(s) or formalized word(s) or phrase(s) used to describe the subject	M	N	CharacterString	Free text or from DDE knowledge system and other relevant vocabularies. At least 3 keywords
12	topicCategory	main theme(s) of the resource. DDE codelist includes the topic categories from ISO19115-1, with extensions for more specific geoscience information topics.	M	N	Code	**Error! Not a valid result for table.**
13	resourceType	Classification of the kind of resource described by this metadata, e.g. Dataset, Service, Model, Document.	M	1	Code	ResourceTypeCode <<CodeList>>
14	resourceResponsibleParty	Agents responsible for or related to the intellectual content of the described resource: author, creator, editor, contributor, funder, pointOfContact	O	N	Class	CI_Responsibility (Table 11)
15	browseGraphic	link to browse graphic that illustrates the data resource NOTE Should include a legend for the graphic, if possible. EXAMPLE A dataset, an organization logo, security constraint or citation graphic.	O	N	Class	CI_OnlineResource (Table 10)
16	additionalDocumentation	other documentation associated with the resource EXAMPLE Related articles, publications, user guides, data dictionaries	O	N	CharacterString	Free text
17	language	designation of the language in the resource content. Use ISO639-2 three letter codes. (see https://www.loc.gov/standards/iso639-2/php/English_list.php). Use multiple entries if the resource is available in more than one language, or if the content uses more than one language.	M	N	Code	LanguageCode <<CodeList>> (ISO 639-2)
18	characterEncoding	designation of the character set to be used to encode the textual value of the resource content.	M	N	Code	CharacterSetCode <<CodeList>> (IANA

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
		Use multiple entries if the resource is available in more than one encoding, or if the content uses more than one encoding.				character set register)
19	restriction	Entity that contains controlled codes and URIs for kind of access or usage restrictions, and optional text explanation of the restrictions	1	N	Class	MD_Constraints (Table 13)
20	edition	version of the cited resource	O	1	CharacterString	Free text
21	dataQuality	quality information for the described resource	O	1	CharacterString	Free text/Quality report and certification should be stated if exist
22	lineage	information about the events, source data, and/or the production process used in construction of the data resource specified	O	N	CharacterString	Free text
23	source	information about the source data used in creating the specified data resource	O	N	CharacterString	Free text
24	acquisitionType	acquisition or observation method of the original source of the dataset or resource or the related resource from which the described data or resource is derived	O	N	Code	AcquisitionCode <<CodeList>>
25	geoTime	temporal extent of the resource content, expressed as free text, particularly its geological historical time point or time duration period with time unit addressed or covered by the dataset or resource.	M	1	CharacterString	Named Geological Time Intervals or free text
26	geographicExtent	Specification of the geographic location related to the resource content	O	N	Class	EX_GeographicExtent (Table 8)
27	temporalExtent	Specification of the temporal location related to the resource content, expressed as the beginning and ending of a time interval, bounded by a calendar date, geologic time scale unit, or temporal position in thousand, million or billion years before present.	O	N	Class	EX_TemporalExtent (Table 12)
28	associatedResource	citation information about the associated resource that describes association between resources to allow users to navigate between related resources	O	N	Class	CI_OnlineResource (Table 10)

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
		in a discovery context NOTE Using the name element.				
29	metadataReference	link to metadata for this resource in other formats or conforming to other conventions.	O	N	Class	CI_OnlineResource (Table 10)
30	Role name: distributionInfo	information documenting how to obtain the resource.	M	N	Class	MD_Distribution (Table 5)
31	Role name: serviceIdentificationInfo	identification of capabilities which a service provider makes available to a service user through a set of interfaces that define a behavior.	C/resourceType = service	1	Class	SV_ServiceIdentification (Table 3)
32	Role name: imageryInfo	Additional information about image data of either remote sensing, microscope, photography or other images	C/resourceType =imagery or a subtype of imagery	1	Class	MD_Imagery (Table 4)

Table 2. MD_Identification elements

Table 3 – Service Identification information (SV_ServiceIdentification)

Documentation of capabilities available through a service endpoint, including the type of service, the operations that can be invoked, any restrictions or conditions to access the service, and data that the service operates on. Information about accessing the service should be included in the distribution/onlineResource element.

NOTE See ISO 19119 for further information

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
33	serviceType	a code value that specifies the kind of operations offered by the service. EXAMPLE 'discovery', 'view', 'download', 'transformation', or 'invoke''	M	1	Code	ServiceTypeCode <<Codelist>>
34	containsOperations	provides information about the operation offered by the service	O	N	CharacterString	Free Text
35	accessProperties	information about the availability of the service, including fees, planned available data and time, ordering instructions, turnaround, etc.	O	1	CharacterString	Free Text
36	operatedDataset	identification of data resource used for the operation of the service. Could be a specific dataset, or identifier for a file format or information interchange file format profile.	C/data as a service exists	N	Class	MD_Identifier (Table 2)
37	endpointDescription	Link to a service-specific online resource that	O	N	Class	CI_OnlineResource (Table

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
		describes the operation of the service in a format for machine parsing, e.g. an OpenAPI document (https://swagger.io/specification/) or OGC capabilities document.				10)

Table 3. SV_ServiceIdentification elements

Table 4 – Imagery information (MD_Imagery)

Information about raster image data or resource that collected or interpreted about an object without being in physical contact with the object. Data processing should be described in the MD_Identification/lineage element.

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
38	sensor	Type of the sensor used to acquire the image. Include specific model number if available. In an RGB image, different sensors might be associated with each color channel.	O	N	CharacterString	Free text
39	platform	Name, type and description of the platform from which the data were acquired	O	1	CharacterString	Free text
40	equipment	instruments for the image data collection EXAMPLE X-ray Powder Diffraction, Raman Spectroscopy, Single Crystal CCD Diffractometer, Electron Microprobe, Hand Camera	O	N	CharacterString	Free text
41	collector	Name or information of the image data collector	O	N	CharacterString	Free text
42	startTime	start time of data collection	O	1	DateTime	Calendar Date and Time
43	endTime	end time of data collection	O	1	DateTime	Calendar Date and Time
44	signalGenerator	The key property of signal source that produces the imagery. EXAMPLE: LA-ICP-MS Mapping: (Energy density, Beam diameter, Scan speed, Line space), Microscope (Single polarized light, Reflected light, Transmitted light), SEM (Secondary electron image, backscattered electron image)	O	N	CharacterString	Free text

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
45	wavelength	width of a band. it refers to the spectral channel of the sensor response, which is the width of each band EXAMPLE 0.45-0.52µm	O	N	CharacterString	Free text
46	processedLevel	processing level of the source data	O	1	Code	ProcessedLevelCode <<CodeList>>

Table 4. MD_Imagery elements

Table 5 – Distribution information (MD_Distribution)

MD_Distribution entity provides information about format, constraints, URLs to obtain the resource, contact information for the resource provider.

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
47	distributionFormat	provides a description of the format of the data to be distributed EXAMPLE ArcGIS shp files, csv, dbf	O	N	CharacterString	Free text
48	onlineResource	on-line information that can be used to contact the individual or organization and online reference to the dataset or resource which provides basic connection information, and also typical information linking to the documents of the distribution.	M	N	Class	CI_OnlineResource (Table 10)
49	distributionResponsibleParty	party from whom the distributed or released data resource may be obtained. This list need not be exhaustive	O	N	Class	CI_Responsibility (Table 11)
50	Role name: spatialRepresentationInfo	digital representation of spatial information in the data resource	C/resourceType = geographicDataset	1	Class	MD_SpatialRepresentation (Table 6)

Table 5. MD_Distribution elements

Table 6 – Spatial representation information (MD_SpatialRepresentation)

Documentation of the method used to represent location in a distribution that includes spatial data. A dataset might have distributions with different resolutions, or vector vs. raster spatial representation, so this entity is associated with MD_Distribution.

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
51	spatialRepresentationType	method used to spatially represent	C/resourceType =	1	Code	SpatialRepresentationTypeCode

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
		geographic information	geographicDataset			<<CodeList>>
52	spatialResolution	factor that provides a general understanding of the density of spatial data in the resource or describes the range of resolutions in which a digital resource should be useful. NOTE This element should be repeated when describing upper and lower range. EXAMPLE 1 1:50000. EXAMPLE 2 15m	O	N	CharacterString	Free text
53	referenceSystemType	type of reference system used EXAMPLE compoundGeographic2D-Parametric	O	1	Code	ReferenceSystemTypeCode <<CodeList>>
54	referenceSystemIdentifier	Identifier for the spatial reference system used to represent location in the spatial data. Recommend using EPSG SRS identifiers (https://spatialreference.org/ref/epsg/)	C/resourceType = geographicDataset	1	Class	MD_Identifier (Table 9)

Table 6. MD_SpatialRepresentation elements

Table 7 – Date information (CI_Date)

Entity that associates a calendar date or date time with a date type that specifies the event associated with the date. See Calendar Date and Time for information about date formatting.

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
55	date	ISO8601 formatted string specifying a calendar date and time.	M	1	Date or DateTime	See Calendar Date and Time
56	dateType	Code term that specifies the event that occurred on the provided date	M	1	Code	DateTypeCode <<CodeList>>

Table 7. CI_Date elements

Table 8 – Geographic extent (EX_GeographicExtent)

Entity that specifies a geographic location related to the resource content. Either at least one geographicIdentifier or the coordinates for the corners of a bounding box are required.

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
57	geographicIdentifier	identifier used to represent a geographic area NOTE A geographic identifier as described in ISO 19112.	C/westBoundLongitude not provided	N	CharacterString	Free text
58	Elevation	range of the elevation or bathymetry about the dataset or resource EXAMPLE "-3000.00m to 2021.58m relative to mean sea level'; string should include the vertical reference system used	O	1	CharacterString	Free text
59	westBoundLongitude	western-most coordinate of the limit of the resource extent, expressed in longitude in WGS84 decimal degrees (positive east) EXAMPLE -120.1234	C/geographicIdentifier not provided	1	Decimal	-180.0<= West Bounding Longitude Value <= 180.0
60	eastBoundLongitude	eastern-most coordinate of the limit of the resource extent, expressed in longitude in WGS84 decimal degrees (positive east)	C/westBoundLongitude is documented	1	Decimal	-180.0 <= East Bounding Longitude Value <= 180.0
61	southBoundLatitude	southern-most coordinate of the limit of the resource extent, expressed in latitude in WGS84 decimal degrees (positive north) EXAMPLE -45.5678	C/westBoundLongitude is documented	1	Decimal	-90.0 <= South Bounding Latitude Value <= 90.0; South Bounding Latitude Value <= North bounding Latitude Value
62	northBoundLatitude	northern-most coordinate of the limit of the resource extent expressed in latitude in WGS84 decimal degrees (positive north)	C/westBoundLongitude is documented	1	Decimal	-90,0 <= North Bounding Latitude Value <= 90,0; North Bounding Latitude Value >= South Bounding Latitude Value

Table 8. EX_GeographicExtent elements

Table 9 – Identifier information (MD_Identifier)

Entity that provide information for the authority and description associated with an identifier string. If the identifier is a URI, is it provided in the code element. If the identifier is locally defined, the identifier string is the code, and the codespace string specifies a namespace, such that the combination of the codespace and code is a globally unique identifier.

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
63	authority	the person or party responsible for maintenance of that namespace	O	1	Class	CI_Responsibility (Table 11)
64	code	alphanumeric value identifying an instance in the namespace NOTE Avoid characters that are not legal in URLs. EXAMPLE: EPSG:4326	M	1	CharacterString	DOI, 5.3.2 DDE Identifier convention, other URI, or a specified character string
65	codeSpace	identifier or namespace in which the code is valid	O	1	CharacterString	No specified domain
66	version	version identifier for the namespace	O	1	CharacterString	No specified domain
67	description	natural language description of the meaning of the code value. EXAMPLE For codeSpace = EPSG, code = 4326, description = WGS-84.	O	1	CharacterString	No specified domain

Table 9. MD_Identifier elements

Table 10 – Online resource information (CI_OnlineResource)

Information documenting a link to access a resource.

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
68	title	title to label this distribution option in user interface	O	1	CharacterString	Free text
69	applicationProfile	Identifier for profile implemented at this distribution point	O	N	CharacterString	Free text
70	description	description of this distribution	O	1	CharacterString	Free text
71	linkage	A web locator to access this distribution.	M	1	URL	
72	function	code for function performed by the online resource, e.g. download, landingPage, queryPage, accessRequest, accessServiceDescription	M	N	Code	FunctionCode <<CodeList>>

Table 10. CI_OnlineResource elements

Table 11 – Responsible party information (CI_Responsibility)

Information about an agent, including individuals, organizations, or automated agents, responsible for some aspect of the resource. The roleType specifies the relation of the agent to the resource.

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
73	Name	name of the party (individual, organization or automated agent)	M	1	CharacterString	Free text/full name or recognized short name
74	identifier	identifier for this agent. Recommend ORCID for people, ROR or organizations. Should be a resolvable URI.	O	1	Class	MD_Identifier (Table 9)
75	country	country of the address	O	1	Code	CountryCode <<CodeList>> – ISO 3166-1
76	electronicMailAddress	address of the electronic mailbox of the responsible organization or individual	O	N	CharacterString	No specified domain
77	roleType	types of roles played by the responsible party	M	N	Code	**Error! Reference source not found.**

Table 11. CI_Responsibility elements

Table 12 – Temporal extent (EX_TemporalExtent)

Entity that specifies the time interval to which the resource content is related. A begin name is required to provide at least a single named geologic era for interoperability.

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
78	beginName	Name of a time interval that starts the temporal extent interval. Should be a name from the International Stratigraphic Chart (https://stratigraphy.org/chart)	M	1	CharacterString	Name from the International Chronostratigraphic Chart (2020)
79	beginIdentifier	Identifier for time interval from geologic time scale that starts the temporal extent interval. URIs can be obtained from http://resource.geosciml.org/vocabulary/timescale/gts2020	O	1	Class	MD_Identifier (Table 9)
80	endName	Informal name of a time interval that ends the temporal extent interval. Should be a name from the International Stratigraphic Chart (https://stratigraphy.org/chart)	O	1	CharacterString	Name from the International Chronostratigraphic Chart (2020)
81	endIdentifier	Identifier for time interval from geologic time scale that	O	1	Class	MD_Identifier (Table 9)

No.	Name / Role name	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
		ends the temporal extent interval. URIs can be obtained from http://resource.geosciml.org/vocabulary/timescale/gts2020				
82	beginDate	A calendar date or dateTime position that begins the temporal extent interval	O	1	Date or DateTime	Calendar Date and Time
83	endDate	A calendar date or dateTime position that ends the temporal extent interval	O	1	Date or DateTime	Calendar Date and Time
84	beginCoordinate	A decimal number that is the time position that begins the temporal extent interval. Units of measure are specified by the coordinateUnits element.	O	1	Decimal	>0
85	endCoordinate	A decimal number that is the time position that ends the temporal extent interval. Units of measure are specified by the coordinateUnits element.	O	1	Decimal	>0
86	coordinateUnits	A code value that specifies the units of measure for numeric time coordinate positions	O	1	enum	{Ka, Ma, Ga}

Table 12, EX_TemporalExtent elements

Table 13 – Access and Usage contraints (MD_Constraint)

Entity that associates a restriction code with the resource and an optional text explanation of the restriction(s)

No.	Name / Role name	Definition	Obligation/Condition	Maximum occurrence	Data type	Domain
87	restrictionText	Text explanation of restrictions asserted by the associated restriction codes.	O	1	Date or DateTime	See Calendar Date and Time
88	restrictionCode	Code term that specifies the kind of restriction asserted on usage or access to the resource	M	N	Code	DateTypeCode <<CodeList>>

Table 13. MD_Constraint elements

Annex A - Geosciences Information Metadata Code List (Normative)

This standard specifies the following conventions and code lists for element values in DDE metadata.

1.AcquisitionCode <<CodeList>>

Codes for specifying data collection method, based on CGI Feature observation method vocabulary (http://resource.geosciml.org/classifier/cgi/featureobservationmethod).

	Code/Concept name (English)	Code/2nd category concept name	Definition
1.	geologicalMapping	Data collected and acquisition mostly in the field by profiling and stationary observation, sampling, and following laboratory analysis, etc., typically, regional field geological mapping	
2.	survey	Data collected with equipment records and following processing with planned profile, or areal/regional data acquisition activity, etc., typically, aeromagnetic survey.	
3.	observation	Data collected by stationary measurement, etc. like ground water monitoring.	
		3.1/direct observation	(CGI) Feature observation is result of direct visual observation by a geologist (http://resource.geosciml.org/classifier/cgi/featureobservationmethod/direct_observation). Direct observation may include observation using a remote camera (e.g. downhole viewer, submarine camera).
		3.2/indirect observation	(CGI) Feature observation based on inference from proxy observation(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/indirect_method)
		3.3/outcrop observation	(CGI) Data collected in field through direct observation of a single outcrop. Observer defines scope of 'single outcrop' - may be one point location, or averaged over an extended but connected area, e.g. a single polygon on a map (http://resource.geosciml.org/classifier/cgi/featureobservationmethod/outcrop_observation).
4.	remoteSensing	Data collected with satellites, airplane platform on drone, etc., typically aero-photography and radar. Also, (CGI) Geologic unit or structure characterized based on remotely sensed data(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/remotely_sensed_data)	
5.	drillBorehole	Collection orrecords of drills and boreholes.	
		5.1/borehole borehole cuttings observation	(CGI) Data based on interpretation of borehole cuttings(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/borehole_cuttings_observation)
		5.2/ borehole geophysical log measurements	(CGI) Data based on interpretation of geophysical measurement obtained by borehole logging tools(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/borehole_geophysical_log_measurements).
		5.3/drill core observation	(CGI) Data collected through observation of a single drill core interval(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/drill_core_observation).
6.	laboratoryInstrumentation	Data or resource from rock specimen and chemical element analyses in laboratories.	
7.	dataIntegrationSynthesis	Data or resource are the result of synthesis from other data or resources, or as the integration of other data or resources.	
		7.1/data from single published description	(CGI) Data are extracted from a published description of the feature(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/data_from_single_published_description)
		7.2/ synthesis from multiple sources	(CGI) Feature observation is based on a synthesis of other observations by some compiler. The compiler may be the same individual that made the source observations (http://resource.geosciml.org/classifier/cgi/featureobservationmethod/synthesis_from_multiple_sources).
		7.3/ synthesis of multiple outcrop observations	(CGI) Data are the result of synthesis from multiple direct observations, possibly by more than one observer(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/synthesis_of_multiple_outcrop_observations).
		7.4/synthesis of multiple published descriptions	(CGI) Data arethe result of synthesis from multiple published descriptions(http://resource.geosciml.org/classifier/cgi/featureobservationmethod/synthesis_of_multiple_published_descriptions).
8.	digital conversion from published source	(CGI) Feature observation is based on published information, converted to a digital representation for database apapplication (http://resource.geosciml.org/classifier/cgi/featureobservationmethod/digital_conversion_from_published_source).	
9.	digitalSimulation	Data generated by digital analyses and simulations with software rather than physical acquisitions.	

10.	data and map compilation	Geoscience data and map compilation from existing data, maps and other resources that are usually scattered and in larger scale and of higher spatial resolution. Or the collation of raw data and their transformation into a format that can be easily manipulated or combined with other data in preparation for further analysis(EiE Glossary, https://inec.org/eie-glossary/data-compilation).
11.	Webweb rResource	Data and resources obtained from the web.
12.	other	Data and resources obtained from other source other than the above.

2.CharacterSetCode <<CodeList>>

Use IANA Character Set register: http://www.iana.org/assignments/character-sets. These are the official names for character sets that may be used on the Internet and may be referred to in Internet documentation. These names are expressed in ANSI_X3.4-1968 which is commonly called US-ASCII or simply ASCII

3.CountryCode <<CodeList>>

Use ISO 3166 Codes for the representation of names of countries and their subdivisions Part 1: Country codes or equivalent.

4.DateTypeCode <<CodeList>>

Extended from https://wiki.esipfed.org/ISO_19115-3_Codelists#CI_DateTypeCode. CI_OnlineResource is used for all links, and the function element indicates the relationship type.

	Code	Concept name (English)	Definition
	adopted	Adopted	date identifies when resource was adopted
	creation	Creation	start date of a data collection, start date of a cruise..
	deprecated	Deprecated	date identifies when resource was deprecated
	distribution	Distribution	date identifies when an instance of the resource was distributed
	inForce	In force	date identifies when resource became in force
	lastRevision	Last revision	date identifies when resource was last reviewed
	lastUpdate	Last update	date identifies when resource was last updated
	nextUpdate	Next update	date identifies when resource will be next updated
	publication	publication	date identifies when the resource was issued
	released	released	the date that the resource shall be released for public access
	revision	revision	date identifies when the resource was examined or re-examined and improved or amended
	superseded	superseded	date identifies when resource was superseded or replaced by another resource
	unavailable	unavailable	date identifies when resource became not available or obtainable
	validityBegins	Validity begins	time at which the data are considered to become valid. NOTE: There could be quite a delay between creation and validity begins
	validityExpires	Validity expires	time after which the resource will no longer be considered to be valid

5.FunctionCode <<CodeList>>

Extended from https://wiki.esipfed.org/ISO_19115-3_Codelists#CI_OnLineFunctionCode.
CI_OnlineResource is used for all links, and the function element indicates the relationship type.

	Code	Concept name (English)	Definition
	browseGraphic	Browse graphic	browse graphic provided (ISO_19115-3)
	browsing	Browsing	online browsing provided (ISO_19115-3)
	completeMetadata	Complete metadata	Link is to a metadata resource with more complete information, or serialized using a different format or metadata profile, as indicated by the application profile in the CI_OnlineResource element. (based on ISO_19115-3)
	coupledResource	Coupled resource	Link is to a resource required by the described service. Only applicable if resourceType = service. CI_OnlineResource/description should explain the nature of the dependency.
	download	Download	Link will get the content of the described resource as a file (based on ISO_19115-3)
	emailService	Email service	online email service provided (ISO_19115-3)
	fileAccess	File access	online file access provided (ISO_19115-3)
	order	Order	online order process for obtaining the resource (ISO_19115-3)
	search	Search	online search interface for seeking out information about the resource (ISO_19115-3)

	Code	Concept name (English)	Definition
	information	Information	online information about the resource (ISO_19115-3)
	offlineAccess	Offline Access	online instructions for requesting the resource from the provider (ISO_19115-3)
	upload	Upload	online resource upload capability provided (ISO_19115-3)

6.LanguageCode <<CodeList>>

Use ISO 639-2. ISO 639-2 is the alpha-3 code in Codes for the representation of names of languages. See https://www.loc.gov/standards/iso639-2/php/code_list.php.

7.ProcessedLevelCode <<CodeList>>

	Code	Concept name (English)	Definition
1	Level 0	Level 0	Raw images
2	Level 1	Level 1	After radiation correction
3	Level 2	Level 2	After systematic geometric correction and radiation correction
4	Level 3	Level 3	After fine geometric correction using ground control points
5	Level 4	Level 4	Data products

8.ReferenceSystemTypeCode <<CodeList>>

Codes that specify kinds of coordinate reference systems use to identify locations.

	Concept name (English)	Code	Definition
1.	compoundEngineering- Parametric	compoundEngineering Parametric	compound spatio-parametric coordinate reference system containing an engineering coordinate reference system and a parametric reference system EXAMPLE[local] x, y, pressure
2.	compoundEngineering- Parametric Temporal	compoundEngineering ParametricTemporal	compound spatio-parametric-temporal coordinate reference system containing an engineering, a parametric, and a temporal coordinate reference system EXAMPLE[local] x, y, pressure, time
3.	compoundEngineer- ingTemporal	compoundEngineering Temporal	compound spatio-temporal coordinate reference system containing an engineering and a temporal coordinate reference system EXAMPLE[local] x, y, time
4.	compoundEngineeringVer- tical	compoundEngineering Vertical	compound spatial reference system containing a horizontal engineering coordinate reference system and a vertical coordinate reference system EXAMPLE [local] x, y, height
5.	compoundEngineeringVer- tical Temporal	compoundEngineeringVertic alTemporal	compound spatio-temporal coordinate reference system containing an engineering, a vertical, and a temporal coordinate reference system EXAMPLE[local] x, y, height, time
6.	compoundGeographic2D Parametric	compoundGeographic 2DParametric	compound spatio-parametric coordinate reference system containing a 2 dimensional geographic horizontal coordinate reference system and a parametric reference system EXAMPLElatitude, longitude, pressure
7.	compoundGeographic2D ParametricTemporal	compoundGeographic 2DParametricTem poral	compound spatio-parametric-temporal coordinate reference system containing a 2 dimensional geographic horizontal, a parametric and a temporal coordinate reference system EXAMPLElatitude, longitude, pressure, time
8.	compoundGeographic2D Temporal	compoundGeographic 2DTemporal	compound spatio-temporal coordinate reference sys- tem containing a 2 dimensional geographic horizontal coordinate reference system and a temporal reference system EXAMPLElatitude, longitude, time
9.	compoundGeographic2D- Vertical	compoundGeographic 2DVertical	compound coordinate reference system in which one constituent coordinate reference system is a horizontal geodetic coordinate reference system and one is a vertical coordinate reference system EXAMPLElatitude, longitude, [gravity-related] height or depth
10.	compoundGeographic2Dvertical Temporal	compoundGeographic VerticalTemporal	compound spatio-temporal coordinate reference system containing a 2 dimensional geographic horizontal, a vertical, and a temporal coordinate reference system EXAMPLE latitude, longitude, height, time
11.	compoundGeographic3D Temporal	compoundGeographic 3DTemporal	compound spatio-temporal coordinate reference system containing a 3 dimensional geographic and a temporal coordinate reference system EXAMPLElatitude, longitude, ellipsoidal height, time

	Concept name (English)	Code	Definition
12.	compoundProjected2DParametric	compoundProjected 2DParametric	compound spatio-parametric coordinate reference system containing a projected horizontal coordinate reference system and a parametric reference system EXAMPLE casting, northing, density
13.	compoundProjected2DParametricTemporal	compoundProjected 2DParametricTem poral	compound spatio-parametric-temporal coordinate reference system containing a projected horizontal, a parametric, and a temporal coordinate reference system EXAMPLE casting, northing, density, time
14.	compoundProjectedTemporal	compoundProjected Temporal	compound spatio-temporal coordinate reference system containing a projected horizontal and a temporal coordinate reference system EXAMPLE casting, northing, time
15.	compoundProjectedVertical	compoundProjected Vertical	compound spatial reference system containing a horizontal projected coordinate reference system and a vertical coordinate reference system EXAMPLE casting, northing, [gravity-related] height or depth
16.	compoundProjectedVertical Temporal	compoundProjected VerticalTemporal	compound spatio-temporal coordinate reference system containing a projected horizontal, a vertical, and a temporal coordinate reference system EXAMPLE casting, northing, height, time
17.	engineering	engineering	coordinate reference system based on an engineering datum (datum describing the relationship of a coordinate system to a local reference) EXAMPLE [local] x,y
18.	engineeringDesign	engineeringDesign	engineering coordinate reference system in which the base representation of a moving object is specified EXAMPLE[local] x,y
19.	engineeringImage	engineeringImage	coordinate reference system based on an image datum (engineering datum which defines the relationship of a coordinate system to an image) EXAMPLE row, column
20.	geodeticGeocentric	geodeticGeocentric	geodetic CRS having a Cartesian 3D coordinate system EXAMPLE[geocentric] X,Y,Z
21.	geodeticGeographic2D	geodeticGeographic2D	geodetic CRS having an ellipsoidal 2D coordinate system EXAMPLElatitude, longitude
22.	geodeticGeographic3D	geodeticGeographic3D	geodetic CRS having an ellipsoidal 3D coordinate system EXAMPLElatitude, longitude, ellipsoidal height
23.	geographicIdentifier	geographicIdentifier	spatial reference in the form of a label or code that identifies a location EXAMPLE post code
24.	linear	linear	reference system that identifies a location by reference to a segment of a linear geographic feature and distance along that segment from a given point EXAMPLE x km along road
25.	parametric	parametric	coordinate reference system based on a parametric datum (datum describing the relationship of a parametric coordinate system to an object) EXAMPLE pressure
26.	projected	projected	coordinate reference system derived from a two-dimensional geodetic coordinate reference system by applying a map projection EXAMPLE casting, northing
27.	temporal	temporal	reference system against which time is measured EXAMPLE time
28.	vertical	vertical	one-dimensional coordinate reference system based on a vertical datum (datum describing the relation of gravity-related heights or depths to the Earth) EXAMPLE [gravity-related] height or depth

9.ResourceTypeCode <<CodeList>>

Includes a subset of ISO19115-3 scope codes[1] applicable to DDE resources in the scope of this specification, with extensions defined here, based on subclasses of CreativeWork in Schema.org, and Dublin Core resource types.

	Code	Level 1 concept name	Level 2 concept name	Definition or description
	aggregate	Aggregate		Set of resources of various types that are grouped into a single resource

[1] http://standards.iso.org/iso/19115/resources/Codelist/cat/codelists.xml#MD_ScopeCode

	Code	Level 1 concept name	Level 2 concept name	Definition or description
				for some purpose. Component resources do not necessarily share the same format or information model. Source ISO19115-3, this vocabulary
	application	Application		See schema.org/SoftwareApplication. An executable unit of functionality. Typically an implementation of some software on a particular platform. Source ISO19115-3, this vocabulary
	webApplication		Web Application	An application that executes on a server via interaction with a human user through a web interface. Source this vocabulary.
	collection	Collection		A set of related resource that share a similar format .(rev from ISO19115-3, schema.org, Dublin Core)
	dataset	Dataset		a collection of numeric or categorical values that convey information, describing the quantity, quality, fact, statistics, other basic units of meaning, or simply sequences of symbols that may be further interpreted formally. Sourcce ISO19115-3, schema.org, Dublin Core, definition based on https://en.wikipedia.org/wiki/Data
	dataCatalog		Data catalog	a kind of dataset in which the records are documentation for datasets. A metadata dataset. schema.org
	geographicDataset		Geographic dataset	Dataset in which thedata are related to a geographic location
	nonGeographicDataset		Non-geographic dataset	Dataset containing data that is not associated with a geographic location.(rev from ISO19115-3)
	document	Document		a written, drawn, presented, or memorialized representation of thought, the manifestation of non-fictional or imaginary content. Source ISO19115-3, https://en.wikipedia.org/wiki/Document
	article		Article	a document that is published in a print or electronic medium as part of a larger work or series. Source schema.org, https://en.wikipedia.org/wiki/Article_(publishing), this vocabulary.
	thesis		Thesis	a document submitted in support of candidature for an academic degree or professional qualification presenting the author's research and findings. Source schema.org, https://en.wikipedia.org/wiki/Thesis, ISO 7144
	book		Book	a document that records information in the form of writing or images, typically composed of many pages bound together and protected by a cover. Source schema.org, https://artsandculture.google.com/entity/book/m0bt_c3
	poster		Poster	a document intended for display on a large screen or printed sheet. Source schema.org, Merriam-Webster
	webPage		Web page	a document accessible on the world wide web, formatted for viewing on a computer screen. Source schema.org, this vocabulary,
	image	Image		visual representation of something. Source Dublin Core
	map		Map	symbolic visual representation of a spatial region. Source schema.org, https://en.wikipedia.org/wiki/Map
	photograph		Photograph	image created by light falling on a photosensitive surface, usually photographic film or an electronic image sensor, such as a CCD or a CMOS chip. Source schema.org, https://en.wikipedia.org/wiki/Photograph
	explanatoryFigure		Explanatory figure	Diagrams, data plots, flow charts, other kinds of graphics generated to present or explain ideas or data. Source this vocabulary.
	initiative	Initiative		activity that produces information resources or artifacts that might be cataloged. Source ISO19115-3
	fieldSession		Field session	initiative that involves collecting data outside of a fixed laboratory environment, in situ, at the location where the subject of the observation is located (e.g. cruise). Source ISO19115-3, this vocabulary
	learningResource	LearningResource		a resource intended to instruct a user about some topic or procedure. Often a composite of text, images, sound, and movie. Source schema.org, this vocabulary
	guide		Guide	a kind of learningResource. Source schema.org
	model	Model		information applies to a copy or imitation of an existing or hypothetical object ISO19115-3, Dublin Core
	movie	Movie		a sequence of consecutive still images recorded in a series to be viewed on a screen in such rapid succession as to give the illusion of natural movement. Source schema.org, https://www.dictionary.com/browse/movie
	repository	Repository		a container for other resources. Source ISO19115-3, this vocabulary
	semanticResource	Semantic resource		resource that defines and information model or vocabulary used for information interchange, e.g. glossary, ontology, data model. . Source this vocabulary.
	definedTermSet		DefinedTerm Set	a set of terms with definitions, typically with identifiers for each term, and all related to some scope. Source schema.org, this vocabulary
	series	Series		a collection of related resources. Source ISO19115-3, this vocabulary.

	Code	Level 1 concept name	Level 2 concept name	Definition or description
	service	Service		a capability that a provider makes available to a user through an interface that define a input and output requirements and offered functionality. (based on ISO19115-3, Dublin Core). This general service category includes services that are invoked via any communication channel. Service is distinguished from Application in that a service is not intended to be interactive in real time. An Application might be constructed using one or more Services.
	webAPI		WebAPI	A service that communicates with the service user via HTTP operations. See https://schema.org/WebAPI
	software	Software		information applies to a computer program or routine ISO19115-3, Dublin Core. See SoftwareSourceCode schema.org
	sound	Sound		resource is a reproducible representation of recorded acoustic phenomena. DublinCore, this vocabulary

10.RestrictionCode <<CodeList>>

Codes to specify limitation(s) placed upon the access or use of the described resource.

	Code	Concept name (English)	Definition
1	confidential	confidential	not available to the public NOTEContains information that could be prejudicial to a commercial, industrial, or national interest.
2	copyright	copyright	exclusive right to the publication, production, or sale of the rights to a literary, dramatic, musical, or artistic work, or to the use of a commercial print or label, granted by law for a specified period of time to an author, composer, artist, distributor
3	inConfidence	in-confidence	with trust
4	intellectualPropertyRights	Intellectual property rights	rights to financial benefit from and control of distribution of non-tangible property that is a result of creativity
5	licence	licence	formal permission to do something
6	licenceDistributor	Licence distributor	formal permission required for a person or an entity to commercialize or distribute the resource
7	licenceEndUser	Licence end user	formal permission required for a person or an entity to use the resource and that may differ from the person that orders or purchases it
8	licenceUnrestricted	Licence unrestricted	formal permission not required to use the resource
9	otherRestrictions	Other restrictions	limitation not listed
10	patent	Patent	government has granted exclusive right to make, sell, use or license an invention or discovery
11	patentPending	Patent pending	produced or sold information awaiting a patent
12	private	Private	protects rights of individual or organizations from observation, intrusion, or attention of others
13	restricted	Restricted	withheld from general circulation or disclosure
14	sbu	Sensitive but unclassified	although unclassified, requires strict controls over its distribution.
15	statutory	Statutory	prescribed by law
16	trademark	Trademark	a name, symbol, or other device identifying a product, officially registered and legally restricted to the use of the owner or manufacturer
17	unrestricted	unrestricted	no constraints exist

11.RoleTypeCode <<CodeList>>

(copied from https://wiki.esipfed.org/ISO_19115-3_Codelists#CI_RoleCode)

	Code	Concept name (English)	Definition
1	author	Author	party who authored the resource
2	coAuthor	Co-Author	party who jointly authors the resource
3	collaborator	Collaborator	party who assists with the generation of the resource other than the principal investigator
4	contributor	Contributor	party contributing to the resource
5	custodian	Custodian	party that accepts accountability and responsibility for the data and ensures appropriate care and maintenance of the resource
6	distributor	Distributor	party who distributes the resource
7	editor	Editor	party who reviewed or modified the resource to improve the content
8	funder	Funder	party providing monetary support for the resource
9	mediator	Mediator	a class of entity that mediates access to the resource and for whom the resource is intended

	Code	Concept name (English)	Definition
			or useful
10	originator	Originator	party who created the resource
11	owner	Owner	party that owns the resource
12	pointOfContact	Point of contact	party who can be contacted for acquiring knowledge about or acquisition of the resource
13	principalInvestigator	Principal Investigator	key party responsible for gathering information and conducting research
14	processor	Processor	party who has processed the data in a manner such that the resource has been modified
15	publisher	Publisher	party who published the resource
16	resourceProvider	Resource provider	party that supplies the resource
17	rightsHolder	Rights holder	party owning or managing rights over the resource
18	sponsor	Sponsor	party that sponsors the resource
19	stakeholder	Stakeholder	party who has an interest in the resource or the use of the resource
20	user	User	party who uses the resource

12.ServiceTypeCode <<Codelist>>

This is a set of categories to populate DDE serviceType for metadata records for which the resourceType is 'Service'. ISO19115-1 does not define a serviceType vocabulary. This vocabulary has been defined by the DDE metadata workgroup.

	Code	Concept name (English)	2nd category concept name	Definition
1	DataService>DataAccess	Data service	1.1/Data Access Service	Service provide filtering and subsetting functions on one or more datasets, based on URL parameters. Operates on a data store provided by the service backend. Includes services for graph queries (e.g. GQL, Cypher) against a graph database and SPARQL queries against an RDF triple store
	DataService>DataWorkflow		1.2/Data workflow service	the service provided for geoscience data acquisition/collection, transfer, integration, storage, modelling, analysis and visualization, etc.
	DataService>DataProcessing		1.3/Data processing service	services provided on geoscience data processing, including disciplinary data processing tools software service (APP), data processing modules (API), data processing web Apps.
	DataService>MapView		1.4/Map service	services to provide a client view, access, or obtain to a geoscientific map product, the graphic data, a vector data map or image map in the format of WMS, WFS, png/jpeg/tiff, etc., for example.
	DataService>Other		1.7/Other data service	data service(s) provided not defined above.
2	DDE_GeoscienceKnowledgeDirectory	Knowledge service	2.1/Geoscience knowledge catalogue service	provides services to return the DDE geoscience knowledge directory of specific disciplines/sub disciplines, or keywords.
	DDE_GeoscienceKnowledgeContent		2.2/Geoscience knowledge content service	provides services to return the DDE geoscience knowledge content (knowledge tuples) of specific disciplines/sub disciplines, or keywords.
	DDE_KnowledgeReasoning		2.3Knowledge reasoning service	provide services to return the related knowledge content (knowledge tuples) obtained by reasoning for the specific keywords
	DDE_DeepShovel		2.4/Deep shovel	provides services of searching and finding information and/or knowledge form published papers.
	DDE_Scholar		2.5/DDE scholar	provides scholar portrait service (literatures and relationships) thru data mining from published journal papers.
	DDE_OtherKnowledge		2.6/Other knowledge service	Other services provided by DDE geoscience knowledge not defined above.
3	DDE_PlatformCatalogue	Platform service	3.1/Catalogue service	provides discovery and management services on DDE platform of metadata about instances. The metadata may be for dataset instances, e.g. dataset catalogue, or may contain service metadata, e.g. service catalogue.
	DDE_PlatformRegistry		3.2/Registry service	provides access to DDE platform. Example registries are information community registries, type dictionaries, service registries and schema registries.
	DDE_PlatformModel		3.3/Model Service	provides discovery and management services on DDE platform

	Code	Concept name (English)	2nd category concept name	Definition
				of metadata about models.
	DDE_PlatformCloudComputing		3.4/Cloud computing resource service	provides web-based computing facilities discovery and management services on DDE platform and DDE Cloud.
	DDE_PlatformAnnotation		3.5Annotation Service	provides discovery and management services on DDE platform of metadata about annotations used on the platform.
	DDE_API_Information		3.6/API Service	provides discovery services on DDE platform of metadata about API information provided by the DDE platform.
	DDE_EarthExplorer		3.7/Earth Explorer	provides a search engine service to search and visualize information, data and knowledge form DDE platform.
	DDE_Platform>DataEvaluation		3.8/Data evaluation service	service for DDE accessible data evaluation based on six aspects/metrics of authority, quality, volume, openness, service capability and user scale metrics.
	DDE_Platform> DataIdentifier		3.9/DDE identifier service	automatically generation of a DDE data code [resourceIdentifier?] to the data resource registered to be DDE resource
	DDE_Platform>Other		3.10/Other platform service	Other services provided by the DDE platform not defined above.
4	Theme>MineralResourceAssessment	Thematic service	4.1/Mineral resource assessment service	service for the regional assessment of specific minerals resources, porphyry copper for example.
	Theme>GeologicMapping		4.9/Geologic mapping service (Global layer)	services for view, access, and obtain geological map products, as well as complete online mapping and publishing, including relevant symbol libraries, etc.
	Theme>GeologicalTime		4.3/Geological timeline service	service for accurate geological timing.
	Theme>GeologicalOccurrence		4.4/Digital geological occurrence service	provides service of visualization of geological observation spots and rock occurrence, etc.
	Theme>Dinosaur		4.5/Dinosaur service	provides service of visualized living scenes of a group of specific dinosaurs in geological history.
	Theme>GeographicName		4.6/Global naming service	services for name(s) globally with geographic position.
	Theme>GeomorphologyMapping		4.7/Geomorphologic mapping service	service for geomorphologic mapping online with relevant data resources.
	Theme>GeoscienceStandard		4.8/Geoscience standards service	service for DDE geoscience standards access and download.
	Theme>Other		4.9/Other thematic service	thematic service(s) provided not defined above.
5	VocabularyService	Vocabulary service		Service implements vocabulary services based on SKOS properties. This category is for generic service provided from source other than DDE platform. Resolve concept URI to preferred label, definitions, related terms; test if a label is present in a vocabulary, return URI for label, etc.
6	RegistryService	Registry service		Service provides interface to interact with a non-DDE resource registry; provides capabilities e.g. to resolve URIs to return descriptions of a registered resource, return resource descriptions based on search criteria including labels, free text, or other properties included in registered resource descriptions.
7	DiscoveryService	Discovery service		Service supports searching a non-DDE metadata catalog to locate resources of interest and return metadata records describing those resources.
8	ViewService	View service		Service provides visualizations of geospatial or tabular data. Works with geospatial data not integrated in DDE platform, in which case service type would be 1.4 DataService/MapService
9	OtherService	Other service		Service that does not fit in any other category.

13.SpatialRepresentationTypeCode <<CodeList>>

Codes that specify the method used to represent geographic information in the resource

	Code	Concept name (English)	Definition
1.	vector	Vector	vector data are used to represent geographic data
2.	grid	Grid	grid data are used to represent geographic data
3.	textTable	Text table	textual or tabular data are used to represent geographic data
4.	tin	Tin	triangulated irregular network
5.	stereoModel	Stereo model	three-dimensional view formed by the intersecting homologous rays of an overlapping pair of images
6.	video	Video	scene from a video recording

14.TopicCategoryCode <<CodeList>>

This codelist extends the ISO19115-1 codelist (see https://wiki.esipfed.org/ISO_19115-3_Codelists#MD_TopicCategoryCode) with more granular topic categories for geoscience resources. The categories in the 1st concept name column are from the ISO19115-3 codelist, except for DataScience, which is added in this vocabulary. Strings in the 'Code' column are those that are used to populate the 'MD_Identification/resourceType' property in metadata instance. The 3rd concept names are more detailed and should be included as keywords.

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
1.	farming	Farming			rearing of animals and/or cultivation of plants. EXAMPLES Agriculture, irrigation, aquaculture, plantations, herding, pests and diseases affecting crops and livestock.
2.	biota	Biota			flora and/or fauna in natural environment. EXAMPLES Wildlife, vegetation, biological sciences, ecology, wilderness, sea life, wetlands, habitat.
3.	boundaries	Boundaries			legal land descriptions, maritime boundaries EXAMPLES Political and administrative boundaries, territorial seas, EEZ, port security zones.
4.	climatologyMeteorologyAtmosphere	Climatology meteorology atmosphere			processes and phenomena of the atmosphere EXAMPLES Cloud cover, weather, climate, atmospheric conditions, climate change, precipitation.
5.	economy	Economy			economic activities, conditions and employment EXAMPLES Production, labor, revenue, commerce, industry, tourism and ecotourism, forestry, fisheries, commercial or subsistence hunting, exploration and exploitation of resources such as minerals, oil and gas.
6.	elevation	Elevation			height above or below a vertical datum. EXAMPLES Altitude, bathymetry, digital elevation models, slope, derived products.
7.	environment	Environment			environmental resources, protection and conservation. EXAMPLES Environmental pollution, waste storage and treatment, environmental impact assessment, monitoring environmental risk, nature reserves, landscape.
8.	geoscientificInformation	Geoscientific information	information pertaining to earth sciences EXAMPLES Geophysical features and processes, geology, minerals, sciences dealing with the composition, structure and origin of the earth's rocks, risks of earthquakes, volcanic activity, landslides, gravity information, soils, permafrost, hydrogeology, erosion. (from ISO19115-2014[E])		
	8_01-stratigraphy		8.1/stratigraphy	The study of rock layers (strata) and layering (stratification), dealing with the description of all rock bodies form the Earth's crust— sedimentary, igneous, and metamorphic— and their organization into distinctive, useful, mappable units based on their inherent properties or attributes. Stratigraphic procedures include the description, classification, naming, and correlation of these units for the purpose of establishing their relationship in space and their succession in time.	
				8.1.1/magnetostratigraphy	Description: The element of stratigraphy that deals with the magnetic characteristics of rock units.

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
				8.1.2/cyclostratigraphy	Description: Cyclostratigraphy is the subdiscipline of stratigraphy that deals with the identification, characterization, correlation, and interpretation of cyclic (periodic or quasi-periodic) variations in the stratigraphic record and, in particular, with their application in geochronology by improving the accuracy and resolution of time-stratigraphic frameworks. It uses astronomical cycles of known periodicities to date and interpret the sedimentary record.
				8.1.3/chronostratigraphy	Description: The element of stratigraphy that deals with the relative time relations and ages of rock bodies.
				8.1.4/sequence stratigraphy	Description: The study of genetically related facies within a framework of chrono-stratigraphically significant surfaces
				8.1.5/lithotratigraphy	Description: The element of stratigraphy that deals with the description and nomenclature of the rocks of the Earth based on their lithology and their stratigraphic relations.
				8.1.6/biostratigraphy	Description: The element of stratigraphy that deals with the distribution of fossils in the stratigraphic record and the organization of strata into units on the basis of their contained fossils.
				8.1.7/chemostratigraphy	Description: The element of stratigraphy that deals with the geochemical signals, such as carbonate cycles and isotope cycles, as recorded in the stratigraphic record.
				8.1.8/event stratigraphy	Event stratigraphy comprises the study of stratigraphical traces of relatively short-lived events (instant to thousands of years) compared to those normally observed on a geological time-scale. Events may be represented by depositional, erosional or geochemical features. (http://quaternary.stratigraphy.org/stratigraphic-guide/event-stratigraphy/)
				8.1.9/geologic time scale	Geological time scale (GTS) is a representation of time based on the rock record of Earth. It is a system of chronological dating that uses chronostratigraphy and geochronology. It is used primarily to describe the timing and relationships of events in geologic history. (From Wikipedia, the free encyclopedia)
	8_02-paleontology		8.2/paleontology	The study of life in the geologic past, based on examination of fossilized remains of once living organisms to clarify their taxonomic classification and interactions with each other and their environments (their paleoecology).	
				8.2.1/Paleoecology	Description: paleoecology is the study of interactions between organisms and/or interactions between organisms and their environments across geologic timescales. As a discipline, paleoecology interacts with, depends on and informs a variety of fields including paleontology, ecology, climatology and biology.
				8.2.2/Fossil	remnant, impression, or trace of an animal or plant of a past geologic age that has been preserved in Earth 's crust. The complex of data recorded in fossils worldwide—known as the fossil record—is the primary source of information about the history of life on Earth. (https://www.britannica.com/science/fossil) (CGI: material fossil: The preserved remains or replaced remains (casts) of plants and animals. A fossil type may have one or more described associated organisms. If particle type is materia lFossil, an additional type property element may provide a reference to a Palcontologic description of the fossil)
				8.2.3/Evolutionary paleontology	Description: Evolutionary palcontology (also called evolutionary palcobiology) is palcontology's intersection with evolutionary biology. Its main aims are to

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
					reconstruct the history of life on earth (historical paleontology, phylogeny) and the patterns and causes of evolutionary change and extinction (biological and physical processes and unique historical events).
				8.2.4/Biostratigraphy	Description: Biostratigraphy is also the branch of stratigraphy and focuses on correlating and assigning relative ages of rock strata by using the fossil assemblages contained within them. The primary objective of biostratigraphy is correlation, demonstrating that a particular horizon in one geological section represents the same period of time as another horizon at a different section.
				8.2.5/Paleoanthropology	Description: Paleoanthropology is the study to understand the early development of anatomically modern humans, a process known as hominization, through the reconstruction of evolutionary kinship lines within the family Hominidae, working from biological evidence (such as petrified skeletal remains, bone fragments, footprints) and cultural evidence (such as stone tools, artifacts, and settlement localities).
				8.2.6/Ichnology	Description: Ichnology is the study of fossils traces, which record biological activity but not the preserved remains of the plant or animal itself, including the tracks, borings, trails, burrows, impressions, and others left by ancient organisms. The study of Ichnology is to gain insight into ancient organisms' behavior and ecology.
				8.2.7/Invertebrate Paleontology	Description: Invertebrate paleontology (also as invertebrate paleozoology or invertebrate paleobiology) is the study of ancient invertebrates by analyzing invertebrate fossils in the geologic record.
				8.2.8/Molecular Paleontology	Description: Molecular paleontology refers to the recovery and analysis of DNA, proteins, carbohydrates, or lipids, and their diagenetic products from ancient human, animal, and plant remains.
				8.2.9/Geobiology	Description: Geobiology is a field of scientific research that explores the interactions between the physical Earth and the biosphere. Geobiology focuses on microorganisms, and on the role that life plays in altering the chemical and physical environment of the pedosphere, which exists at the intersection of the lithosphere, atmosphere, hydrosphere and/or cryosphere.
				8.2.10/Paleobotany	Description: Paleobotany is the study dealing with the recovery and identification of plant remains from geological contexts, and their use for the biological reconstruction of past environments, and the evolutionary history of plants, with a bearing upon the evolution of life in general. Paleobotany includes the study of terrestrial plant fossils and prehistoric marine photoautotrophs, such as photosynthetic algae, seaweeds or kelp.
				8.2.11/Palynology	Description: Palynology is the study of microscopic objects of macromolecular organic composition (i.e., compounds of carbon, hydrogen, nitrogen and oxygen), not capable of dissolution in hydrochloric or hydrofluoric acids". It studies contemporary and fossil palynomorphs, including pollen, spores, orbicules, dinocysts, acritarchs, chitinozoans and scolecodonts, together with particulate organic matter and kerogen found in sedimentary rocks and sediments.
				8.2.12/Taphonomy	Description: Taphonomy studies how organism decay and become fossilized or preserved in the fossil record.
				8.2.13/Micropaleontology	Description: Micropaleontology studies microfossils (generally smaller than 1

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
					mm) that require using microscope to observe and to study organism's morphology and characteristic details.
				8.2.14/Paleobiogeography	Description:Biogeography within the venue of the fossil record in which fossils provide the data. Incorporates ecology, evolution, and geological processes, and use of the fossil record provides a time component that results in multiple time slices to examine biogeographic pattern.
	8_03-geochronology		8.3/geochronology	the science of determining the age of rocks, fossils, and sediments using signatures inherent in the rocks themselves. Absolute geochronology can be accomplished through radioactive isotopes, whereas relative geochronology is provided by tools such as paleomagnetism and stable isotope ratios. By combining multiple geochronological (and biostratigraphic) indicators the precision of the recovered age can be improved.	
				8.3.1/radio isotopic dating	Description: a dating method based on the rates of radiogenic decay which is proportional to time.
				8.3.2/non-radio isotopic dating	Description: dating method that does not rely on the measurements of radiogenic decay.
	8_04-sedimentology		8.4/sedimentology	Description: Sedimentology is a scientific discipline concerned with the physical and chemical properties of sedimentary rocks as well as the processes involved in their formation, such as sediment transportation, deposition, and lithification (conversion to rock). The interpretation of ancient environmental conditions in sediment source areas and depositional sites is a key objective of such sedimentological study. Sedimentologists examine the constituents, textures, structures, and fossil content of deposits formed in various geographic environments. They can distinguish between continental, littoral, and marine deposits in the geologic record. *(https://www.vedantu.com/geography/sedimentology)* (CGI: sedimentary material: Material formed by accumulation of solid fragmental material deposited by air, water or ice, or material that accumulated by other natural agents such as chemical precipitation from solution or secretion by organisms. Includes both sediment and sedimentary rock. Includes epiclastic deposits.).	
				8.4.1/sedimentary rock	The study of sedimentary rocks, which formed by accumulation and cementation of solid fragmental material deposited by air, water or ice, or as a result of other natural agents, such as precipitation from solution, the accumulation of organic material, or from biogenic processes, including secretion by organisms. Includes epiclastic deposits. *(CGI)*
				8.4.2/sedimentary physical property	The study of physical features of a sedimentary environment includes water depth and the velocity and persistence of currents. Chemical characteristics of an environment include the salinity (proportion of dissolved salts), acidity or basicity (pH), oxidation potential (Eh), pressure, and temperature. *(Wikipedia)*
				8.4.3/sedimentary geochemistry	Sedimentary geochemistry has been in use to understand the conditions of deposition, climatic variations, tectonic setting, provenance, reservoir characteristics, etc. *However, characterization of depositional units for distinction and correlation based on stratigraphic variation of geochemical traits and usage of the term "chemostratigraphy" have been more frequent only from the 1980s. (ScienceDirect)*
				8.4.4/sedimentary process	The study of how sedimentary rocks are formed, including erosion, weathering, dissolution, lithification, precipitation, etc. *(WorldAtlas)*
	8_05-magmaticPetrology		8.5/ magmatic petrology	Description: magmatic or igneous petrology is the study of macroscopic and microscopic mineralogical and chemical composition of igneous rocks (or magmatic rocks)—formed through the cooling and solidification of molten material (magma or lava) either within the earth's crust or at crust the surface of the earth. The modern study of igneous rocks utilizes many techniques, some of them developed in the fields of chemistry,	

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
				physics, or other earth sciences. Mineralogy, crystallography, and isotopy studies are common methods used in igneous petrology. *(from "Igneous rocks" by Jerram D. and Petford N. (2004), Robin Gill (2010) and Wikipedia).*	
				8.5.1/Composition and classification	The compositions include mineral and geochemical compositions of igneous rocks. The classification of igneous rocks refers to classifying igneous rocks according to their mineral and geochemical compositions. The rocks are generally classified into ultramafic, mafic, intermediate, and acidic igneous rocks, and some special and unclassified igneous rocks. *(from "Igneous rocks" by Tomkieff S.T.(1983), R.W.Le Maitre (2002), Best M G (2003) and Wikipedia)*
				8.5.2/Geochemical properties	Geochemical properties of igneous rocks include major and trace elements and isotopic compositions; etc. The chemistry of igneous systems provides clues to many important whole-earth evolution processes, including the origins of igneous, processes and timing of planetary differentiation, the production and destruction of the lithosphere, and the relationships between magmatic styles, composition, crust growth, mantle-crust convection, and plate-tectonic environment.
				8.5.3/Physical properties	The physical properties of igneous rocks are observable, measurable, and describable physical properties of igneous rocks and magma processes, including the occurrence in the field, texture, (ductile and brittle) structure of igneous rocks, as well as the physical properties of magma, such as temperature, pressure, and rheology etc. *(from "Igneous rocks" by Jerram D. and Petford N. (2004) and Wikipedia)*
				8.5.4/Magmatism and origin	Magmatism or magmatic activity is the emplacement of magma within and at the surface of the outer layers of a terrestrial planet, which solidifies as igneous rocks. It does so through magmatic activity or igneous activity, the production, intrusion, and extrusion of magma or lava. Volcanism is the surface expression of magmatism. The origin of igneous rocks is to study the source of magma, magma generation, magmatism, and other properties related to igneous formation. *(from "Igneous rocks" by Robin Gill (2010) and Wikipedia)*
	8_06-metamorphicPetrology		8.6/metamorphic petrology	The study of metamorphic rock arises from the transformation of existing rock to new types of rock in a process called metamorphism, which includes solid-state mineralogical, chemical and/or structural changes.	
				8.6.1/metamorphic fabrics	Description: The relative orientation of parts of a metamorphic rock mass. Broadly, it also refers metamorphic textures and structures. Metamorphic textures develop in the solid state as mineral grains interact with their neighbors during deformation, recrystallization, and/or growth. Structure is the arrangement of the parts of a rock mass irrespective of scale, including spatial relationships between the parts, their relative size and shape and the internal features of the parts.
				8.6.2/dynamic metamorphism	Description: A type of metamorphism of local extent, associated with fault zones or shear zones.
				8.6.3/impact metamorphism	Description: A type of metamorphism of local extent caused by the passage of a shock wave due to the impact of a planetary body (projectile or impactor) on a planetary surface (target). It includes melting and vaporization of the target rock(s).
				8.6.4/contact	Description: A type of metamorphism of local extent that affects the country rocks

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
				metamorphism	around magma bodies emplaced in a variety of environments from volcanic to upper mantle depths, in both continental and oceanic settings.
				8.6.5/metasomatism	Description: Metasomatism: is a metamorphic process by which the chemical composition of a rock or rock portion is altered in a pervasive manner and which involves the introduction and/or removal of chemical components as a result of the interaction of the rock with aqueous fluids (solutions). During metasomatism the rock remains in a solid state.
				8.6.6/regional metamorphism	Description: A type of metamorphism which occurs over an area of wide extent, that is, affecting a large rock volume, and is associated with large-scale tectonic processes, such as ocean-floor spreading, crustal thickening related to plate collision, deep basin subsidence, etc.
				8.6.7/ocean-floor metamorphism	Description: A type of metamorphism of regional or local extent related to the steep geothermal gradient occurring near spreading centers in oceanic environments.
				8.6.8/burial metamorphism	Description: A type of metamorphism, mostly of regional extent, which affects rocks deeply buried under a sedimentary-volcanic pile and is typically not associated with deformation or magmatism.
				8.6.9/magmatism	Description: A composite silicate metamorphic rock, pervasively heterogeneous on a meso- to megascopic scale. It typically consists of darker and lighter parts. The darker parts usually exhibit features of metamorphic rocks whereas the lighter parts are of igneous-looking appearance (see also leucosome, melanosome, mesosome, neosome, palaeosome). Wherever minerals other than silicates and quartz are substantially involved, it should be explicitly mentioned.
				8.6.10/metamorphic history	Description: Metamorphic history includes the metamorphic facies, metamorphic series, metamorphic zones, and P-T-t paths of a rock or a geological unit. A metamorphic facies is a set of metamorphic mineral assemblages, repeatedly associated in time and space and showing a regular relationship between mineral composition and bulk chemical composition. A series of metamorphic facies developed under a particular range of P/T. A succession of metamorphic zones characterized by distinctive index minerals. The surfaces separating the zones, represented by lines on a metamorphic map, are isograds.
	8_07-structureGeology		8.7/structure geology	Description: the study of the three-dimensional distribution of rock units with respect to their deformational histories. The primary goal of structural geology is to use measurements of present-day rock geometries to uncover information about the history of deformation (strain) in rocks, and ultimately, to understand the stress field that resulted in the observed strain and geometrics.	
				8.7.1/historical structure	Description: the study of deformational histories of rock units in deep time period. Basically, historical structure deals with deformation that occurs before Quaternary.
				8.7.2/active structure(neo-structure)	Neo-Structure and Active Structure are sub-disciplines of tectonics that study the process of recent tectonic deformation and tectonic geomorphic evolution on the Earth. The time scale of neo-structure research is closely related to the geodynamics of a specific region; it typically concerns geological processes at time scales from Ma to ka, and emphasizes on the relationship between the past and present tectonic deformation. On the other hand, research in active tectonics pays greater attention to geological–geomorphological processes since 100~150ka,

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					and focuses on present and future tectonic deformation. That is, in comparison with neo-structure, active structure is typically used to describe those movement that have occurred over the time-span of human history and it deals with the societal implications of neo-structure, such as seismic-hazard assessment, future sea-level rise, etc., because it focuses on crustal movements that can be expected to recur within a future interval of concern to society.
	8_08-tectonics		8.8/tectonics	The study of the processes that control the structure and properties of the Earth's crust and its evolution through time.	
				8.8.1/plate tectonics	Description: Plate tectonics, also known as the theory of plate tectonics, a unifying theory developed to explain Earth's dynamics. lithosphere. The theory of plate tectonics describes these motions and accounts for most observable tectonic activity in the Earth, as well as the tectonic history recorded in the ocean basins. The theory holds that the Earth's lithosphere is divided at present into seven major and several minor plates that are in motion with respect to one another and that the motion of each plate is, to a first approximation, a rigid-body motion.
				8.8.2/deep Earth tectonics	Description: the study of Earth's interior layers and related features, including mantle, core, subducting slab, plume, LLSVPs, discontinuities etc., beneath the depth of the Moho surface.
				8.8.3/thermochronology	Description: the study of the thermal evolution of a region of a planet. Thermochronology uses radiometric dating along with the concept of closure temperature that represents the temperature of the mineral being studies at the time given by the date recorded to understand the thermal history of a specific rock, mineral, or geologic unit. Thermochronology is closely associated with geochronology.
				8.8.4/geodynamics	Description: geodynamics is subfield of Tectonics or Geophysics dealing with dynamics of the Earth. It applies physics, chemistry, geology, and mathematics to the understanding of how mantle convections lead to plate tectonics and geologic phenomena such as seafloor spreading, mountain building, volcanoes, earthquakes, faulting etc. Methods of Geodynamics are also applied to exploration other planets.
	8_09-geologicMapping		8.9/geologic mapping	The interpretive, geoscientific process that produces a range of map products for many different uses, including assessing ground-water quality and contamination risks; predicting earthquake, volcano, and landslide hazards; characterizing energy and mineral resources and their extraction costs; waste repository siting; land management and land-use planning; and general education. The products include geological, tectonic, seismological, geophysical and geochemical maps at different scales.	
				8.9.1/geological survey	It is the processes of collecting geological data and study geology by a variety of methods as field profiling, drilling, remote sensing and sampling etc.
				8.9.2/geological compilation	The study of geoscience map compilation. A geological map may be compiled from other maps, usually of larger scale, or may be produced from original geoscientific surveys and photogrammetric compilations.
				8.9.3/digital geological mapping	Description: digital geological mapping refers to the process of using computer software to form digital geological map or to construct database of geological maps.
	8_10-hydrogeology		8.10/hydrogeology	The area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust, commonly in aquifers. Geology of ground water and hydrology, also including ground water	

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
				dynamic, mining hydrogeology, regional hydrogeology, etc.	
				8.10.1/Storage of groundwater	Description: Occurring state and hydrological properties of groundwater in rock and soil.
				8.10.2/Groundwater flow	Description: The movement of water through interconnected voids in the phreatic zone
				8.10.3/groundwater quality.	Description: A general term for the physical, chemical and biological properties of groundwater.
				8.10.4/Geological processes of groundwater	Description: The occurrence and movement of groundwater affects a wide range of geologic processes in diverse environments.
				8.10.5/Groundwater dependent ecosystems	Description: Ecosystems which depend on groundwater permanently or intermittently to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
	8_11-engineeringGeologyGeotechnology		8.11/engineering geology(geotechnology)	Description: Engineering Geology is the science devoted to the investigation, study and solution of the engineering and environmental problems which may arise as the result of the interaction between geology and the works and activities of man as well as to the prediction and of the development of measures for prevention or remediation of geological hazards.	
				8.11.1/regional engineering geology	Description: Regional Stability is defined as the degree of stability of a particular region which may be affected by crustal movements with differential vertical displacements and horizontal movements, volcanic activities, and fault activities. It is especially associated with those strong activities which may trigger earthquakes and consequent regional mass wasting processes such as rock falls, landslides, debris flow, liquefaction, plastic flows of clay, and uneven surface subsidence.
				8.11.2/soil mass engineering geology	Description: Soil Mass Engineering Geology is the science that studies the engineering properties of soil to solve engineering geological problems related to engineering activities, predict and demonstrate the occurrence and development laws of engineering geological problems, and propose technical measures for their improvement and prevention, for the planning, design, construction, use and development of engineering activities.
				8.11.3/rock mass engineering geology	Description: Rock Mass Engineering Geology is the scientific domain of Engineering Geology and Rock Mechanics, which focuses on the laws of formation and evolution of rock masses and their engineering behavior through the theories and methods of geomechanics.
				8.11.4/applied engineering geology	Description: Applied Engineering Geology is an applied geology discipline that provides data indispensable to the design and geotechnical solution for engineering structures. The subject comprises the modes of application of engineering geology, case histories, evaluation of investigations, design and realization of structures as well as their observation during and after construction.
				8.11.5/geological hazards	Description: geological hazards are those natural geologic processes or man-made geologic conditions that represent a present-day or future hazard to man's life, health, or property. Six typical geological hazards, i.e., landslides, debris flows, rockfalls, avalanches, earthquakes, and volcanoes.
				8.11.6/intelligent engineering geology	Description: Intelligent Engineering Geology (IEG) is to combine innovative concepts with the new generation of information technology to intelligently collect EG information, mine the existing EG knowledge, reveal the spatial-temporal

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					characteristics and the evolution of engineering geological bodies, and predict their future development trends.
	8_12-environmentalGeology		8.12/environmental geology		an applied science concerned with the practical application of the principles of geology in the solving of environmental problems created by man. It is a multidisciplinary field that is closely related to engineering geology and, to a lesser extent, to environmental geography *(Wikipedia)*
	8_13-petroleumGeology		8.13/petroleum geology	The study of origin, occurrence, movement, accumulation, and exploration of hydrocarbon fuels. It refers to the specific set of geological disciplines that are applied to the search for hydrocarbons (oil exploration).	
				8.13.1/Oil and gas resources assessment	Description: Oil and gas resource evaluation refers to the process of estimating or analyzing the subsurface oil and gas endowment in a specific geological entity.
				8.13.2/Geological elements	Description: Petroleum exploration is largely concerned with the search for oil and gas. Geological elements in petroleum geology include source rocks, reservoirs, seals and traps.
				8.13.3/Petroleum accumulation	Description: Petroleum accumulation refers to the geological process of oil and gas entrapment in sedimentary basins through migration in the carrier beds and finally filling into traps following the generation of oil and gas.
	8_14-mathematicalGeoscience		8.14/mathematical geoscience	The study of the application of mathematical methods to solve problems in geosciences.	
				8.14.1/data visualization	Description: Data visualization is the graphical representation of information and data.
				8.14.2/analysis	Description: Analysis is the process of breaking a complex topic or substance into smaller parts in order to gain a better understanding of it.
				8.14.3/modelling	Description: A formal expression of an idea which may be used to try to explain a set of observed data, by comparing its deduced behavior to the actual observed data, or to predict the outcome of an event.
				8.14.5/computation	Description: Computation is any type of calculation that includes both arithmetical and non-arithmetical steps and follows a well-defined model
	8_15-marineGeology		8.15/marine geology	The study of the history and structure of the ocean floor from shorelines to the continental shelf and deep sea. It involves geophysical, geochemical, sedimentological and paleontological investigations of the ocean floor and coastal zone.	
				8.15.1/Submarine Geomorphology	Description: Submarine geomorphology investigates the morphology and evolution of seafloor landforms, and the processes responsible for their formation, in particular erosion and depositional processes, sediment movement and deformation, volcanic activity, fluid migration, and anthropogenic impacts.
				8.15.2/Marine sedimentology	Description: Marine sedimentology involves the description, classification, modeling, and interpretation of marine sediments so as to determine the physical, chemical, and biological processes by which they formed.
				8.15.3/Marine sediment dynamics	Description: Marine sediment dynamics aims at studying the motion of sediment particles during their formation, transport, and settling processes *(Zhang, 2014)*.
				8.15.4/Paleoceanography and paleoclimatology	Description: Paleoceanography and paleoclimatology are the study of the oceans (with regard to circulation, chemistry, biology, geology and patterns of sedimentation and biological productivity) and climates as they were in the past, from a few hundred years to billions of years ago *(Thomas, 2009)*.
				8.15.5/Marine geochronology	Description: The geochronology is the determination of ages and time intervals for geologic materials, including marine sediments, and processes on geologic, archeologic, and historic time scales. It is the science of investigating the

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
					chronology of the earth constituents as induced from geologic data, based on absolute and relative dating methods.
				8.15.6/Marine petrology	Description: Marine petrology studies the mineralogy, textures, and chemical composition of igneous, sedimentary, and metamorphic rocks, since their composition reflects the conditions at which they were formed and the time they needed to develop.
				8.15.7/Marine geochemistry	Description: Marine geochemistry is the study of the chemistry of geological materials such as rocks, sediments and water.
				8.15.8/Seafloor tectonics and geodynamics	Description: Seafloor tectonics and geodynamics study the genesis, aging, motion, and destruction of oceanic plates *(Koppers and Coggon, 2020)* and their interactions with the earth's interior.
				8.15.9/ Marine Geohazards	Description: Marine geohazards are geological conditions at the sea floor or within sub-bottom sediments that, if unrecognized, could result in dangerous or catastrophic events with attendant risks to life and/or infrastructure. The major marine geohazards are coastal erosion, seawater intrusion, earthquakes, submarine landslides, subsidence, tsunamis, natural gas hydrate dissociation, seabed sand waves, shallow gas, overpressure strata, gas chimneys, mud volcanoes and mud diapirism
				8.15.10/ Coastal Morpho dynamics	Description: Understanding and predicting the changes in the morphology of the coastal zone, including the topography of the sea bed and the shoreline planform, in connection with waves, currents, tides and sea level rise.
				8.15.11/ Marine Palcontology and Micropalcontology	Description: Marine Palcontology and Micropalcontology is the study of ancient fossils and microfossils in the sediments in order to reconstruct past conditions of oceans and environments.
				8.15.12 Seafloor habitat	Description: a combination of elements that include both physical structure and dimension, and biological characteristics of specific species or groups of species under consideration *(Diaz et al. 2004)*.
				8.15.13 Subseafloor biosphere	Description: The Subseafloor biosphere represents the subseafloor ecosystems themselves and the environments (e.g., hydrothermal systems and cold seeps) that sustain them.
	8_16-mineralogy		8.16/mineralogy	The study of natural minerals that formed on Earth and delivered from other planets as meteorites, which underpins and supports the whole earth science system.	
				8.16.1/mineral properties and its applications	Description: The properties of minerals are extremely important in understanding geological phenomena and in synthesizing new materials.
				8.16.2/crystallography	Description: Crystallography is the study of the external form and the crystal structure of crystalline solids and the principles that govern their growth, shape, and internal atomic arrangement.
				8.16.3/mineral genesis and Its Occurrence	Description: The mineral genesis and its occurrence is an important part of mineralogy, mainly throughthe study of minerals characteristics, mineral species and mineral assemblages to reflect the formation conditions and processes.
				8.16.4/mineral classification and description	Description: study of the scheme of mineral classifications that are determined in the light of chemical composition and internal structure.
				8.16.5/chemical composition and crystal	Description: Chemical composition refers to identity and number of the chemical elements that make up any particular compound. Crystal structure is a description

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				structure	of the ordered arrangement of atoms, ions or molecules in a crystalline material.
	8_17-gravimetricAndGravityExploration		8.17/gravimetric and gravity exploration	The study of the measurement and application of the strength of a gravitational field or the properties of matter responsible for its creation for solid earth and geological exploration. Gravity exploration is one of the common and primary geophysical exploration methods. It is based on the density difference between the target object and its surroundings. By eliminating the influenceduc to the factors unrelated to the studied targets on the gravity measurements, the gravity anomalies caused by ore bodies, structure or other density inhomogeneous bodies can be obtained.	
	8_18-geomagnetismAndMagneticExploration		8.18/geomagnetism and magnetic exploration	The study of measurement and application of the Earth's total magnetic field or of components of the field in various directions to solve problems of geosciences and for exploration. Magnetic exploration is to investigate subsurface geology on the basis of anomalies in the Earth's magnetic field resulting from the magnetic properties of the underlying rocks. It can be performed on land, at sea and in the air.	
	8_19-geoelectricityAndElectricalExploration		8.19/geoelectricity and electrical exploration	The study of measurement and application of the electrical parameters of the underground geological structures and subsurface media and bodies (rocks, sediments, water, voids, etc.) both with passive or active to solve problems of geosciences and for exploration. Electrical exploration is an applied discipline that observes and studies electric and electromagnetic fields established naturally or artificially underground, and solves various geological problems related to the difference in the electrical properties of rocks and ores.	
	8_20-seismologyAndSeismicExploration		8.20/seismology and seismic exploration	The study of the propagation of elastic waves through the Earth or through other planet-like bodies, including studies for petroleum and other resources exploration, and study of earthquake and relevant environmental effects such as tsunamis as well as diverse seismic sources such as volcanic, tectonic, glacial, fluvial, oceanic, atmospheric, and artificial processes such as explosions.	
	8_21-nuclearGeophysicsandRadioactiveExploration		8.21/nuclear geophysics and radioactive exploration	nuclear geophysics is the study of changing law of natural and artificial nuclear radiation fields in the medium through corresponding methods and instruments, on the basic theory of atomic and nuclear physics, geology, geophysics, radiochemistry and other disciplines, so as to achieve methods for mineral exploration and to solve related geological problems. Radioactive exploration is the studies of measurement and application of the radioactive characteristics of subsurface media and radioactive values of rocks and minerals in exploration and geological dating to solve problems of geosciences.	
	8_22-drillAndGeophysicalLogging		8.22/drill and geophysical logging	Description: geological drills and collecting data for physical and petrophysical properties. Geophysical logging is based on physics (electric, nuclear, magnetic, etc.), mathematics and geology as the theoretical basis, with the borehole and its surrounding media as the object of research, using a variety of specialized instruments and equipment, along the drilling profile to measure relevant physical parameters for oil and gas, coal, mineral resources, groundwater exploration, etc.	
				8.22.1/Instruments for drilling and well logging	Description: by using specially drilling tools and processing, collecting rock and sediment samples and then measuring properties of the samples at laboratory
				8.22.2/Coring and core analysis	Description: by using specially drilling tools and processing, collecting rock and sediment samples and then measuring properties of the samples at laboratory
				8.22.3/Logging data analysis	the process of interpreting computer-generated records called logs or logging data. interpretation handles the correlation between logs and geological events, in addition, to explore geological resources and to support geological engineering.
	8_23-paleomagnetism		8.23/paleomagnetism	The study of the record of the Earth's magnetic field in rocks, sediment, or archeological materials to reveal the past behavior of Earth's magnetic field and the past location of tectonic plates.	
	8_24-rockphysics		8.24/ rock physics	Description: Rock physics studies the behavior and physicochemical properties of reservoir rocks in different environments such as surface and underground, including the characteristics of reservoir rocks themselves, as well as their interactions with oil, gas and water, and is a comprehensive marginal discipline that mainly	

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				describes the physical properties of pore geology, the interaction between different fluids and rock pore surfaces. It is the theoretical basis of logging, geophysical exploration and reservoir engineering.	
	8_25-integratedgeophysics		8.25/integrated geophysics	Description: integrated geophysics is the application of geophysical methods, including gravity, electrical, magnetic, seismic and other methods, which can be used in the ocean, energy, environmental and other geophysical exploration problems. In order to achieve the best exploration effect, the combination of multiple geophysical methods can effectively reduce the multi-solution problem in the interpretation of a single geophysical exploration method and improve the reliability of geophysical exploration interpretation.	
	8_26-geochemistry		8.26/geochemistry	Description: the science that uses the tools and principles of chemistry to study the geoscience. It includes isotope geochemistry, biogeochemistry, organic geochemistry, regional, environmental and exploration geochemistry, such as rock geochemical exploration, soil geochemical exploration, stream sediment geochemical exploration, atmospheric geochemical exploration, biogeochemical exploration, water geochemical exploration, geo-gas survey, chemical analysis, geochemical mapping, geothermal manifestation, radiometric dating, etc.	
				8.18.1/surficial geochemistry	Description: The chemical principles and processes on the Earth surface
	8_27-remoteSensing		8.27/remote sensing	The acquisition of information about an object or phenomenon without making physical contact with the object, especially to acquiring information aboutthe Earth for the study of hydrology, ecology, meteorology, oceanography, glaciology, geology, etc.	
				8.27.1/Remote Sensing Infrastructure	Description: Remote Sensing Infrastructure is the study focused on the mechanism, hardware, and software for remote sensing technology. It is especially associated with those devices and data analysis and process methods of the remote sensing system, including the sensors, sensing platforms, electromagnetic spectrum characteristics, and remote sensing data algorithms.
				8.27.2/Applied Remote Sensing	Description: Applied remote sensing is the study that to obtain target information by using remote sensing technology or to obtain target attributes by analyzing remote sensing data.
				8.27.3/Photogrammetry	Description: Photogrammetry is to obtain the shape, size, position, characteristics, and relationships of the subject by the remote sensing images. Its main task is to measure topographic maps of various scales, establish topographic databases, provide spatial basic data for various geographic information systems, land information systems, and various projects, and serve non-topographic fields.
	8_28-geomorphology		8.28/geomorphology	The study of the origin and evolution of topographic and bathymetric features created by physical, chemical or biological processes operating at or near the Earth's surface.	
				8.28.1/special geomorphology	Description: Special geomorphology is a discipline that takes the landforms and its geomorphic evolution formed by some geological agents (such as fluvial landforms, aeolian landform, glacial landform, karst landform, coastal landform, etc) as its independent research object.
				8.28.2/dynamical geomorphology	Description: Dynamic geomorphology is a discipline that studies the role of various geomorphic dynamics in geomorphic processes.It can be divided into endodynamic geomorphology and exokinetic geomorphology.It applies the principles and methods of basic sciences such as mathematics, physics and chemistry to study the mechanism of landform formation, focusing on the modern process of landform formation and the relationship between landform and various action variables.
				8.28.3/regional geomorphology	Description: Regional geomorphology studies the geomorphology of an area. It analyzes its topographic characteristics, genetic dynamics, geomorphic evolution,

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					geographical distribution and composition characteristics, including regional geomorphology studies at different spatial scales, such as global geomorphology, intercontinental geomorphology, plate geomorphology, national geomorphology, and local regional geomorphology etc.
				8.28.4/applied geomorphology	Description: Applied geomorphology is a discipline that studies how to apply the principles and methods of geomorphology to solve production practice. It links the study of geomorphology closely to the transformation of nature and its decision-making processes. It relates to environmental studies, resource surveys, disaster prevention, soil and water conservation, etc. Applied geomorphology includes multiple sub-fields, for example, agricultural geomorphology, engineering geomorphology and mining geomorphology.
				8.28.5/experimental geomorphology	Description: Experimental geomorphology is the science of natural observation or indoor modelling of a selected geomorphic body or process with the aid of certain observational tools and controlled conditions. Its objective is to reveal the relationship between the development of landforms and different factors, and to represent mathematically the mechanism of the development of landforms. Experimental geomorphology has developed rapidly in recent years. In addition to the early physical model experiment, it also includes quantitative geomorphology, which uses mathematical methods to study the surface morphology and its formation and evolution through the analysis of various geographical physical quantities, digital geomorphology, which is a branch of geomorphology that studies geomorphic morphology, landform types, spatial distribution, geomorphic formation and evolution process through comprehensive analysis of remote sensing images, digital terrain model (DTM) and other relevant geomorphic data under the geographic information system environment.
				8.28.6/geomorphological mapping	Description: Geomorphological mapping is the process of visualizing the scale, spatial distribution, classification or regionalization of various geomorphological objects and phenomena on a map. It is an important method and tool for geomorphological investigation and research, as well as a powerful illustration and supplement to the written description of geomorphological phenomena. The results of geomorphological mapping include geomorphological classification maps, geomorphological regionalization maps, etc.
				8.28.7/climatic geomorphology	Description: Climatic geomorphology is the study of the processes of landform formation and their evolution under different climatic conditions, and is an important branch of geomorphology.
				8.28.8/quantitative geomorphology	Description: Quantitative geomorphology is the study of land surface morphology, its formation and development through the analysis of quantitative data using mathematical methods. It includes the acquisition of quantitative data, the quantification of non-quantitative information, the processing and analysis of data, the creation of models and the simulation of geomorphological processes.
				8.28.9/fractal geomorphology	Description: The science of using fractal methods and principles to study the surface morphology and its occurrence, development and distribution is called fractal geomorphology.
				8.28.10/historical geomorphology	Description: The science of using fractal methods and principles to study the surface morphology and its occurrence, development and distribution is called

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
					fractal geomorphology.
	8_29-paleoclimatology		8.29/paleoclimatology	The study of reconstruction of ancient climate to understand natural variation and the evolution of the current climate, for which direct measurements were not taken. It utilize variety of proxy methods from Earth and life sciences to obtain data previously preserved within rocks, sediments, boreholes, ice sheets, tree rings, corals, shells, and microfossils. Combined with techniques to date the proxies, the paleoclimate records are used to determine the past states of Earth's atmosphere.	
	8_30-paleogeography		8.30/paleogeography	The study of historical geography, generally physical landscapes. It can also include the study of human or cultural environments.	
				8.30.1/lithofacies paleogeography	Description: lithofacies paleogeography is a discipline that uses lithofacies analysis to reconstruct sedimentary environments and landforms during geological history and to study the distribution and evolution of sedimentary facies, with the task of providing basic theory and applied methods for resource prediction.
				8.30.2/tectono-paleogeography	Description: Tectono-paleogeography (Plate tectonic) illustrates the plate tectonic development of the Earth , including the location of active plate boundaries and the changing extent of both oceanic and continental plates.
				8.30.3/climate paleogeography	Description: climate paleogeography refers to adding climatic information to the traditional paleogeography maps by using deep time climate classifications.
				8.30.4/paleobiogeography	Description: paleobiogeography is the study of the geographical distribution of faunas and floras in the past.
	8_31-earthResource		8.31/earth resource	It contains two main resources: renewable resources and non-renewable resources. Non-renewable resources are the naturally resources that cannot be readily replaced by natural means such as oil and gas, minerals and metal ores, ground water, etc.	
				8.31.1/mineral resource	Mineral resources of the earth, including mineral geology, mineral exploration, mineral exploitation, etc.
				8.31.2/groundwater	Groundwater of the Earth in aquifers, including groundwater exploration, groundwater production, etc.
				8.31.3/oil and gas	It includes oil and gas exploration, exploitation or production, and oil and gas field, etc.
				8.31.4/shale gas and oil shale	It includes geology, exploration, production and others of oil shale or shale gas.
				8.31.5/coal and coalbed methane	It includes coal geology and coalbed methane geology, coal and coalbed methane exploration, coal and coalbed methane production and products, etc.
				8.31.6/gas hydrate	It includes both natural and experimental gas hydrate, gas hydrate geology, gas hydrate exploration, gas hydrate exploitation, etc.
				8.31.7 organic material	It is related to Earth material composed of organic compounds derived from the remains of dead organisms and their waste products in the environment. *(CGI)*
	8_32-geothermics		8.32/geothermics	It is related to energy and may refer to heat that comes from within the Earth. It includes geothermal geology, geothermal exploration, geothermal exploitation, geothermal tourism, etc.	
				8.32.1/Theoretical geothermics	Description: Theoretical geotherm is a subject to explore the fundamental topics such as the thermal structure of crust and mantle, the deep thermal state and the formation mechanism and control factors of the thermal evolution of lithosphere structure.
				8.32.2/Applied geothermics	Description: Applied geotherm is a subject to investigate the geothermal resource types, origin and distribution, geothermal resource exploration, geothermal resource evaluation, geothermal resource development and utilization, and

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
					geothermal disaster.
				8.32.3/geothermal energy	It is the heat energy that comes from the subsurface of the earth which contained in the rocks and fluids beneath the crust and originates from the formation of the planet or geological movements and radioactive decay of mass materials.
				8.32.4/dry hot rock	It includes underground dry hot rock exploration and utility, etc.
	8_33-geoexploration		8.33/geo-exploration	Activities of searching for or discovery of Earth resources. It includes mineral exploration activities such as reconnaissance, assessment and surface and subsurface exploration, ore geology, mining pilot, mining regulation and law, and relevant administration.	
	8_34-mining		8.34/mining	The activities of extraction of valuable minerals or other geological materials form the earth.	
	8_35-economicalGeology		8.35/economical geology	the study of fuels, metals, and other materials from the earth that are of interest to industry or the economy in general. It is concerned with the distribution of resources, the costs and benefits of their recovery, and the value and availability of existing materials. *(Wikipedia)*	
				8.35.1/characteristics of ore deposits	Description: The systematically information describing the attributes of the mineral deposits.
				8.35.2/deposit type	Description: A class representing all the recognized mineral deposits that are defined by physical and genetic factors that can be consistently differentiated from those of other classes or deposit types. *(Bureau of Mines. Dictionary of mining, mineral, and related terms[M]. American Geological Institute, 1997)*
				8.35.3/ore genesis	Description: The origin of ores. @ United States. Bureau of Mines. Dictionary of mining, mineral, and related terms[M]. American Geological Institute, 1997.
				8.35.4/metallogeny	Description: Metallogeny is the study of the genesis and regional-to-global distribution of mineral deposits, with emphasis on their relationship in space and time to regional petrologic and tectonic features of the Earth's crust. *(Gilbert J M, Park Jr C F. The geology of ore deposits[M]. Waveland Press, 2007)*
	8_36-geologicalLiteraturc		8.36/geological literature	Literatures of and about geology	
				8.36.1/dinosaur	The study and presentation of dinosaurs for geoscience and the public.
				8.36.2/geopark	The study and management of the UNESCO Geopark that are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development.
				8.36.3/geo-education	Geo-education involves both in-school and out-of-school learning. In school, geo-education takes place across many subjects in the traditional curriculum. Outside of school, geo-education takes place through guided experience in both the human and natural worlds.
				8.36.4/geological publications	Publications of geology, such as books, periodicals, magazines, etc.
				8.29.5/geological Archives	Geological reports and written materials that mostly are not published
	8_37-planetaryGeology		8.37/planetary geology	Description: Planetary geology, alternatively known as astrogeology or exogeology, is a planetary science discipline concerned with the geology of the celestial bodies such as the planets and their moons, asteroids, comets, and meteorites.	
	8_38-biogeology		8.38/biogeology	the study of the interactions between the Earth's biosphere and the lithosphere.	
	8_39-volcanology		8.39/volcanology	the study of volcanoes, lava, magma and related geological, geophysical and geochemical phenomena (volcanism). *(Wikipedia)*	

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
	8_40-forensicGeology		8.40/forensic geology	Forensic geology can be considered to be any aspect of geologic science that is subject to public debate in a court of law. Forensic geology applies the defining principles of the geologic sciences to the identification/evaluation of geologic materials that may be related to forensic problems. *(John W. Lindemann: ENVIRONMENTAL AND ENGINEERING GEOLOGY - Vol. III)*	
	8_41-otherGeoscientificTopics		8.41/other geoscientific topics	any topic(s) related with geosciences that cannot be defined by the above categories.	
9.	health	Health			health, health services, human ecology, and safety EXAMPLES Disease and illness, factors affecting health, hygiene, substance abuse, mental and physical health, health services.
10.	imageryBaseMapsEarthCover	Imagery base maps earth cover			base maps EXAMPLES Land cover, topographic maps, imagery, unclassified images, annotations.
11.	intelligenceMilitary	Intelligence military			military bases, structures, activities EXAMPLES Barracks, training grounds, military transportation, information collection.
12.	inlandWaters	Inland waters			inland water features, drainage systems and their characteristics EXAMPLES Rivers and glaciers, salt lakes, water utilization plans, dams, currents, floods, water quality, hydrologic information.
13.	location	Location			positional information and services EXAMPLES Addresses, geodetic networks, control points, postal zones and services, place names.
14.	oceans	Oceans			features and characteristics of salt water bodies (exclud- ing inland waters). EXAMPLES Tides, tsunamis, coastal information, reefs.
15.	planningCadastre	Planning cadastre			information used for appropriate actions for future use of the land. EXAMPLES Land use maps, zoning maps, cadastral surveys, land ownership.
16.	society	Society			characteristics of society and cultures. EXAMPLES Settlements, anthropology, archaeology, education, traditional beliefs, manners and customs, demographic data, recreational areas and activities, social impact assessments, crime and justice, census information.
17.	structure	Structure			man-made construction. EXAMPLES Buildings, museums, churches, factories, housing, monuments, shops, towers.
18.	transportation	Transportation			means and aids for conveying persons and/or goods EXAMPLES Roads, airports/airstrips, shipping routes, tunnels, nautical charts, vehicle or vessel location, aero- nautical charts, railways.
19.	utilitiesCommunication	Utilities Communication			energy, water and waste systems and communications infrastructure and services. EXAMPLES Hydroelectricity, geothermal, solar and nuclear sources of energy, water purification and distribution, sewage collection and disposal, electricity and gas distribution, data communication, telecommunication, radio, communication networks.
20.	extraTerrestrial	Extra-terrestrial			region more than 100 km above the surface of the Earth
21.	disaster	Disaster			information related to disasters. EXAMPLES Site of the disaster, evacuation zone, disaster-prevention facility, disaster relief activities.

	Code	1st concept name	2nd concept name	3rd concept name	Definition or description
22	dataScience	Data science			an interdisciplinary field that uses scientific methods, processes, algorithms and systems to extract or extrapolate knowledge and insights from noisy, structured and unstructured data, and apply knowledge from data across a broad range of application domains. NOTE data science is related to data mining, machine learning and big data.

Annex B - XML Schema definition for DDE geoscience information metadata

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
 targetNamespace="https://www.ddeworld.org/resource/metadata/1.0"
 xmlns:metadata="https://www.ddeworld.org/resource/metadata/1.0"
 xmlns:xlink="http://www.w3.org/1999/xlink">
 <xs:element name="MD_Metadata">
  <xs:complexType>
   <xs:sequence>
    <xs:element name="metadataIdentifier" type="metadata:MD_Identifier"/>
    <xs:element name="metadataStandardName" type="xs:string"
     default="DDE S01-2023: Geosciences Information Metadata"/>
    <xs:element name="metadataResponsibleParty" type="metadata:CI_Responsibility"
     maxOccurs="unbounded"/>
    <xs:element name="metadataDate" type="metadata:CI_Date" minOccurs="1" maxOccurs="unbounded"/>
    <xs:element name="identificationInfo" type="metadata:MD_Identification"/>
   </xs:sequence>
  </xs:complexType>
 </xs:element>

 <xs:complexType name="MD_Identifier">
  <xs:sequence>
   <xs:element name="authority" type="xs:string" minOccurs="0" maxOccurs="1"/>
   <xs:element name="code" type="xs:anyURI"/>
   <xs:element name="codeSpace" type="xs:string" minOccurs="0" maxOccurs="1"/>
   <xs:element name="version" type="xs:string" minOccurs="0" maxOccurs="1"/>
   <xs:element name="description" type="xs:string" minOccurs="0" maxOccurs="1"/>
  </xs:sequence>
 </xs:complexType>

 <xs:complexType name="MD_Identification">
  <xs:sequence>
   <xs:element name="resourceIdentifier" type="metadata:MD_Identifier"/>
   <xs:element name="title" type="xs:string"/>
   <xs:element name="alternateTitle" type="xs:string" minOccurs="0" maxOccurs="unbounded"/>
   <xs:element name="resourceDate" type="metadata:CI_Date" minOccurs="0" maxOccurs="unbounded"/>
   <xs:element name="abstract" type="xs:string "/>
   <xs:element name="keyword" type="metadata:StringW_ID" minOccurs="1" maxOccurs="unbounded"/>
   <xs:element name="topicCategory" type="metadata:TopicCategoryCode" minOccurs="1"
    maxOccurs="unbounded"/>
```

```
    <xs:element namc="resourceTypc" type="metadata:ResourceTypeCode" maxOccurs="unbounded"/>
    <xs:element name="resourceResponsibleParty" type="metadata:CI_Responsibility" minOccurs="0"
     maxOccurs="unbounded"/>
    <xs:element name="browseGraphic" type="metadata:CI_OnlineResource" minOccurs="0"
     maxOccurs="unbounded"/>
    <xs:element namc="additionalDocumentation" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="language" type="xs:string" minOccurs="1" maxOccurs="1"/>
    <xs:element name="characterEncoding" type="xs:string" minOccurs="1" maxOccurs="1"
     default="utf8">
      <xs:annotation>
       <xs:documentation>Use IANA Character Set register:
        http://www.iana.org/assignments/character-sets. These are the official names for
        character sets that may be used on the Internet and may be referred to in Internet
        documentation. These names are expressed in ANSI_X3.4-1968 which is commonly called
        US-ASCII or simply ASCII</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="restriction" type="metadata:MD_Constraints" minOccurs="1"
     maxOccurs="unbounded"/>
    <xs:element name="edition" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="dataQuality" type="metadata:StringW_ID" minOccurs="0" maxOccurs="1"/>
    <xs:element name="lineage" type="metadata:StringW_ID" minOccurs="0" maxOccurs="1"/>
    <xs:element name="source" type="metadata:StringW_ID" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="acquisitionType" type="metadata:AcquisitionCode" minOccurs="0"
     maxOccurs="unbounded"/>
    <xs:element name="geoTime" type="xs:string" minOccurs="1" maxOccurs="1"/>
    <xs:element name="geographicExtent" type="metadata:EX_GeographicExtent" minOccurs="0"
     maxOccurs="unbounded"/>
    <xs:element name="temporalExtent" type="metadata:EX_TemporalExtent" minOccurs="0"
     maxOccurs="unbounded"/>
    <xs:element name="associatedResource" type="metadata:CI_OnlineResource" minOccurs="0"
     maxOccurs="unbounded"/>
    <xs:element name="metadataReference" type="metadata:CI_OnlineResource" minOccurs="0"
     maxOccurs="unbounded"/>
    <xs:element name="distributionInfo" type="metadata:MD_Distribution" maxOccurs="unbounded"/>
    <xs:element name="serviceIdentificationInfo" type="metadata:SV_ServiceIdentification"
     minOccurs="0" maxOccurs="1"/>
    <xs:element name="imageryInfo" type="metadata:MD_Imagery" minOccurs="0" maxOccurs="1"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType namc="EX_TemporalExtent">
  <xs:sequence>
    <xs:element namc="bcginNamc" type="xs:string"/>
```

```
    <xs:element name="beginIdentifier" type="metadata:MD_Identifier" minOccurs="0" maxOccurs="1"/>
    <xs:element name="endName" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="endIdentifier" type="metadata:MD_Identifier" minOccurs="0" maxOccurs="1"/>
    <xs:element name="beginDate" type="metadata:DateTime" minOccurs="0" maxOccurs="1"/>
    <xs:element name="endDate" type="metadata:DateTime" minOccurs="0" maxOccurs="1"/>
    <xs:element name="beginCoordinate" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
    <xs:element name="endCoordinate" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
    <xs:element name="coordinateUnits" type="metadata:TemporalUnitsEnum" minOccurs="0"
      maxOccurs="1"/>
   </xs:sequence>
</xs:complexType>

<xs:simpleType name="TemporalUnitsEnum">
  <xs:restriction base="xs:token">
    <xs:enumeration value="Ka"/>
    <xs:enumeration value="Ma"/>
    <xs:enumeration value="Ga"/>
  </xs:restriction>
</xs:simpleType>

<xs:complexType name="EX_GeographicExtent">
  <xs:sequence>
    <xs:element name="geographicIdentifier" type="metadata:MD_Identifier" minOccurs="0"
      maxOccurs="unbounded"/>
    <xs:element name="westBoundLongitude" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
    <xs:element name="eastBoundLongitude" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
    <xs:element name="southBoundLatitude" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
    <xs:element name="northBoundLatitude" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
    <xs:element name="elevation" type="xs:string" minOccurs="0" maxOccurs="1"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="SV_ServiceIdentification">
  <xs:sequence>
    <xs:element name="serviceType" type="xs:string" maxOccurs="unbounded"/>
    <xs:element name="containOperations" type="xs:string" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="accessProperties" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="operatedDataset" type="metadata:MD_Identifier" minOccurs="0"
      maxOccurs="unbounded"/>
    <!-- see https://www.energistics.org/sites/default/files/2023-03/EIP_v1.1.pdf section 4.6.2 -->
    <xs:element name="endpointDescription" type="metadata:CI_OnlineResource" minOccurs="0"
      maxOccurs="1"/>
  </xs:sequence>
</xs:complexType>
```

```
<xs:complexType name="MD_Imagery">
 <xs:sequence>
  <xs:element name="sensor" type="xs:string" minOccurs="0" maxOccurs="1"/>
  <xs:element name="platform" type="xs:string" minOccurs="0" maxOccurs="1"/>
  <xs:element name="startTime" type="metadata:DateTime" minOccurs="0" maxOccurs="1"/>
  <xs:element name="endTime" type="metadata:DateTime" minOccurs="0" maxOccurs="1"/>
  <xs:element name="signalGenerator" type="xs:string" minOccurs="0" maxOccurs="1"/>
  <xs:element name="wavelength" type="xs:string" minOccurs="0" maxOccurs="1"/>
  <xs:element name="processingLevel" type="metadata:ProcessedLevelCode" minOccurs="0"
   maxOccurs="1"/>
 </xs:sequence>
</xs:complexType>

<xs:complexType name="MD_Distribution">
 <xs:sequence>
  <xs:element name="distributionFormat" type="metadata:StringW_ID" minOccurs="0"
   maxOccurs="unbounded"/>
  <xs:element name="onlineResource" minOccurs="1" maxOccurs="unbounded"
   type="metadata:CI_OnlineResource"/>
  <xs:element ref="metadata:spatialRepresentationInfo" minOccurs="0" maxOccurs="1"/>
  <xs:element name="distributionResponsibleParty" type="metadata:CI_Responsibility"
   minOccurs="0" maxOccurs="unbounded"/>
 </xs:sequence>
</xs:complexType>


<xs:element name="spatialRepresentationInfo">
 <xs:complexType>
  <xs:sequence>
   <xs:element name="spatialRepresentationType" type="metadata:SpatialRepresentationTypeCode"/>
   <xs:element name="spatialResolution" type="xs:string" minOccurs="0" maxOccurs="unbounded"/>
   <xs:element name="referenceSystemType" minOccurs="0" type="metadata:ReferenceSystemTypeCode"/>
   <xs:element name="referenceSystemIdentifier" type="metadata:MD_Identifier"/>
  </xs:sequence>
 </xs:complexType>
</xs:element>

<xs:complexType name="CI_OnlineResource">
 <xs:sequence>
  <xs:element name="title" type="xs:string" minOccurs="0" maxOccurs="1"/>
  <xs:element name="applicationProfile" type="metadata:StringW_ID" minOccurs="0"
   maxOccurs="unbounded"/>
  <xs:element name="description" type="xs:string" minOccurs="0" maxOccurs="1"/>
```

```
    <xs:element name="linkage" type="xs:anyURI"/>
    <xs:element name="function" type="metadata:FunctionCode" minOccurs="0"/>
   </xs:sequence>
</xs:complexType>

<xs:complexType name="StringW_ID">
  <xs:simpleContent>
    <xs:extension base="xs:string">
      <xs:attribute name="uri" type="xs:anyURI" use="optional"/>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>

<xs:complexType name="CI_Date">
  <xs:sequence>
    <xs:element name="date" type="metadata:DateTime"/>
    <xs:element name="dateType" type="metadata:DateTypeCode"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="CI_Responsibility">
  <xs:sequence>
    <xs:element name="name" type="xs:string"/>
    <xs:element name="role" type="metadata:RoleTypeCode" minOccurs="1" maxOccurs="1"/>
    <xs:element name="identifier" minOccurs="0" type="metadata:MD_Identifier"/>
    <xs:element name="country" type="xs:NCName"/>
    <xs:element name="electronicMailAddress" type="xs:string" nillable="true"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="MD_Constraints">
  <xs:sequence>
    <xs:element name="restrictionText" type="metadata:StringW_ID" minOccurs="0"/>
    <xs:element name="restrictionCode" type="metadata:RestrictionCode" minOccurs="0"
      maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>

<xs:simpleType name="DateTime">
  <xs:annotation>
    <xs:documentation>DateTime element for DDE allows YYYY, YYYY-MM, YYYY-MM-DD, and
      YYYY-MM-DDThh:mm:ss </xs:documentation>
  </xs:annotation>
  <xs:union memberTypes="xs:date xs:dateTime xs:gYear xs:gYearMonth"/>
```

```
</xs:simpleType>

<!-- ================================================================== -->
<!-- ======================codelists ================================== -->

<xs:simpleType name="AcquisitionCode">
  <xs:restriction base="xs:token">
    <xs:enumeration value="geological mapping"/>
    <xs:enumeration value="survey"/>
    <xs:enumeration value="observation"/>
    <xs:enumeration value="direct observation"/>
    <xs:enumeration value="indirect observation"/>
    <xs:enumeration value="outcrop observation"/>
    <xs:enumeration value="remote sensing"/>
    <xs:enumeration value="drill borehole"/>
    <xs:enumeration value="borehole cuttings observation"/>
    <xs:enumeration value="geophysical log measurements"/>
    <xs:enumeration value="drill core observation"/>
    <xs:enumeration value="laboratory instrumentation"/>
    <xs:enumeration value="data integration synthesis"/>
    <xs:enumeration value="single published description"/>
    <xs:enumeration value="multiple sources"/>
    <xs:enumeration value="multiple outcrop observations"/>
    <xs:enumeration value="multiple published descriptions"/>
    <xs:enumeration value="digital conversion from published source" />
    <xs:enumeration value="digital simulation"/>
    <xs:enumeration value="data and map compilation"/>
    <xs:enumeration value="web resource"/>
    <xs:enumeration value="other"/>
    <xs:enumeration value="missing"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="DateTypeCode">
  <xs:restriction base="xs:token">
    <xs:enumeration value="adopted"/>
    <xs:enumeration value="creation"/>
    <xs:enumeration value="deprecated"/>
    <xs:enumeration value="distribution"/>
    <xs:enumeration value="inForce"/>
    <xs:enumeration value="lastRevision"/>
    <xs:enumeration value="lastUpdate"/>
    <xs:enumeration value="nextUpdate"/>
    <xs:enumeration value="publication"/>
```

```
    <xs:enumeration value="released"/>
    <xs:enumeration value="revision"/>
    <xs:enumeration value="superseded"/>
    <xs:enumeration value="unavailable"/>
    <xs:enumeration value="validityBegins"/>
    <xs:enumeration value="validityExpires"/>

  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="FunctionCode">
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    <xs:enumeration value="browsing"/>
    <xs:enumeration value="completeMetadata"/>
    <xs:enumeration value="coupledResource"/>
    <xs:enumeration value="download"/>
    <xs:enumeration value="emailService"/>
    <xs:enumeration value="fileAccess"/>
    <xs:enumeration value="order"/>
    <xs:enumeration value="search"/>
    <xs:enumeration value="information"/>
    <xs:enumeration value="offlineAccess"/>
    <xs:enumeration value="upload"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="ProcessedLevelCode">
  <xs:restriction base="xs:token">
    <xs:enumeration value="Level_0"/>
    <xs:enumeration value="Level_1"/>
    <xs:enumeration value="Level_2"/>
    <xs:enumeration value="Level_3"/>
    <xs:enumeration value="Level_4"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="ReferenceSystemTypeCode ">
  <xs:restriction base="xs:token">
    <xs:enumeration value="compoundEngineeringParametric"/>
    <xs:enumeration value="compoundEngineeringParametricTemporal"/>
    <xs:enumeration value="compoundEngineeringTemporal"/>
    <xs:enumeration value="compoundEngineeringVertical"/>
    <xs:enumeration value="compoundEngineeringVerticalTemporal"/>
```

```
    <xs:enumeration value="compoundGeographic2DParametric"/>
    <xs:enumeration value="compoundGeographic2DParametricTemporal"/>
    <xs:enumeration value="compoundGeographic2DTemporal"/>
    <xs:enumeration value="compoundGeographic2DVertical"/>
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    <xs:enumeration value="compoundGeographic3DTemporal"/>
    <xs:enumeration value="compoundProjected2DParametric"/>
    <xs:enumeration value="compoundProjected2DParametricTemporal"/>
    <xs:enumeration value="compoundProjectedTemporal"/>
    <xs:enumeration value="compoundProjectedVertical"/>
    <xs:enumeration value="compoundProjectedVerticalTemporal"/>
    <xs:enumeration value="engineering"/>
    <xs:enumeration value="engineeringDesign"/>
    <xs:enumeration value="engineeringImage"/>
    <xs:enumeration value="geodeticGeocentric"/>
    <xs:enumeration value="geodeticGeographic2D"/>
    <xs:enumeration value="geodeticGeographic3D"/>
    <xs:enumeration value="geographicIdentifier"/>
    <xs:enumeration value="linear"/>
    <xs:enumeration value="parametric"/>
    <xs:enumeration value="projected"/>
    <xs:enumeration value="temporal"/>
    <xs:enumeration value="vertical"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="ResourceTypeCode">
  <xs:restriction base="xs:token">
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    <xs:enumeration value="Application"/>
    <xs:enumeration value="Web Application"/>
    <xs:enumeration value="Collection"/>
    <xs:enumeration value="Dataset"/>
    <xs:enumeration value="DataCatalog"/>
    <xs:enumeration value="GeographicDataset"/>
    <xs:enumeration value="NonGeographicDataset"/>
    <xs:enumeration value="Document"/>
    <xs:enumeration value="Article"/>
    <xs:enumeration value="Thesis"/>
    <xs:enumeration value="Book"/>
    <xs:enumeration value="Poster"/>
    <xs:enumeration value="WebPage"/>
    <xs:enumeration value="Image"/>
    <xs:enumeration value="Map"/>
```

```
    <xs:enumeration valuc="Photograph"/>
    <xs:enumeration valuc="ExplanatoryFigure"/>
    <xs:enumeration value="Initiative"/>
    <xs:enumeration value="FieldSession"/>
    <xs:enumeration value="LearningResource"/>
    <xs:enumeration valuc="Guidc"/>
    <xs:enumeration value="Model"/>
    <xs:enumeration value="Movie"/>
    <xs:enumeration valuc="Repository"/>
    <xs:enumeration value="Semantic resource"/>
    <xs:enumeration value="DefinedTermSet"/>
    <xs:enumeration value="Series"/>
    <xs:enumeration value="Service"/>
    <xs:enumeration value="WebAPI"/>
    <xs:enumeration valuc="Software"/>
    <xs:enumeration value="Sound"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="RestrictionCode">
  <xs:restriction base="xs:token">
    <xs:enumeration valuc="copyright"/>
    <xs:enumeration valuc="patent"/>
    <xs:enumeration value="patentPending"/>
    <xs:enumeration value="trademark"/>
    <xs:enumeration valuc="licencc"/>
    <xs:enumeration value="intellectualPropertyRights"/>
    <xs:enumeration value="restricted"/>
    <xs:enumeration value="otherRestrictions"/>
    <xs:enumeration value="unrestricted"/>
    <xs:enumeration value="licenceUnrestricted"/>
    <xs:enumeration value="licenceEndUser"/>
    <xs:enumeration value="licenceDistributor"/>
    <xs:enumeration value="private"/>
    <xs:enumeration value="statutory"/>
    <xs:enumeration value="confidential"/>
    <xs:enumeration value="SBU"/>
    <xs:enumeration value="in-confidence"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="RoleTypeCode ">
  <xs:annotation>
    <xs:documentation>Specifies the relationship of an agent to some aspect of a described
```

```
    resource. Copied from
    https://wiki.esipfed.org/ISO_19115-3_Codelists#CI_RoleCode</xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:token">
   <xs:enumeration value="author">
    <xs:annotation>
     <xs:documentation>party who authored the resource</xs:documentation>
    </xs:annotation>
   </xs:enumeration>
   <xs:enumeration value="coAuthor"/>
   <xs:enumeration value="collaborator"/>
   <xs:enumeration value="contributor"/>
   <xs:enumeration value="custodian"/>
   <xs:enumeration value="distributor"/>
   <xs:enumeration value="editor"/>
   <xs:enumeration value="funder"/>
   <xs:enumeration value="mediator"/>
   <xs:enumeration value="originator"/>
   <xs:enumeration value="owner"/>
   <xs:enumeration value="pointOfContact"/>
   <xs:enumeration value="principalInvestigator"/>
   <xs:enumeration value="processor"/>
   <xs:enumeration value="publisher"/>
   <xs:enumeration value="resourceProvider"/>
   <xs:enumeration value="rightsHolder"/>
   <xs:enumeration value="sponsor"/>
   <xs:enumeration value="stakeholder"/>
   <xs:enumeration value="user"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="ServiceTypeCode ">
  <xs:annotation>
   <xs:documentation>Codes to categorize service types. DDE- specific serivce types have
    DDE_prefix.</xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:token">
   <xs:enumeration value="DataService>DataAccess"/>
   <xs:enumeration value="DataService>DataWorkflow"/>
   <xs:enumeration value="DataService>DataProcessing"/>
   <xs:enumeration value="DataService>MapView"/>
   <xs:enumeration value="DataService>Other"/>
   <xs:enumeration value="DDE_GeoscienceKnowledgeDirectory"/>
   <xs:enumeration value="DDE_GeoscienceKnowledgeContent"/>
```

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    <xs:enumeration value="DDE_KnowledgeReasoning"/>
    <xs:enumeration value="DDE_DeepShovel"/>
    <xs:enumeration value="DDE_Scholar"/>
    <xs:enumeration value="DDE_OtherKnowledge"/>
    <xs:enumeration value="DDE_PlatformCatalogue"/>
    <xs:enumeration value="DDE_PlatformRegistry"/>
    <xs:enumeration value="DDE_PlatformModel"/>
    <xs:enumeration value="DDE_PlatformCloudComputing"/>
    <xs:enumeration value="DDE_PlatformAnnotation"/>
    <xs:enumeration value="DDE_API_Information"/>
    <xs:enumeration value="DDE_EarthExplorer"/>
    <xs:enumeration value="DDE_Platform>DataEvaluation"/>
    <xs:enumeration value="DDE_Platform>DataIdentifier"/>
    <xs:enumeration value="DDE_Platform>Other"/>
    <xs:enumeration value="Theme>MineralResourceAssessment"/>
    <xs:enumeration value="Theme>GeologicMapping"/>
    <xs:enumeration value="Theme>GeologicalTime"/>
    <xs:enumeration value="Theme>GeologicalOccurrence"/>
    <xs:enumeration value="Theme>Dinosaur"/>
    <xs:enumeration value="Theme>GeographicName"/>
    <xs:enumeration value="Theme>GeomorphologyMapping"/>
    <xs:enumeration value="Theme>GeoscienceStandards"/>
    <xs:enumeration value="Theme>Other"/>
    <xs:enumeration value="VocabularyService"/>
    <xs:enumeration value="RegistryService"/>
    <xs:enumeration value="DiscoveryService"/>
    <xs:enumeration value="ViewService"/>
    <xs:enumeration value="OtherService"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="SpatialRepresentationTypeCode">
  <xs:annotation>
    <xs:documentation>Codes that specify the method used to represent geographic information in
      the resource</xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:token">
    <xs:enumeration value="vector"/>
    <xs:enumeration value="grid"/>
    <xs:enumeration value="textTable"/>
    <xs:enumeration value="tin"/>
    <xs:enumeration value="stereoModel"/>
    <xs:enumeration value="video"/>
  </xs:restriction>
```

```
</xs:simpleType>

<xs:simpleType name="TopicCategoryCode">
  <xs:annotation>
    <xs:documentation>This codelist extends the ISO19115-1 codelist (see
      https://wiki.esipfed.org/ISO_19115-3_Codelists#MD_TopicCategoryCode) with more granular
      topic categories for geoscience resources. The categories that do not have an '8_' prefix
      are from the ISO19115-3 codelist, except for DataScience, which is added in this
      vocabulary.</xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:token">
    <xs:enumeration value="farming"/>
    <xs:enumeration value="biota"/>
    <xs:enumeration value="boundaries"/>
    <xs:enumeration value="climatologyMeteorologyAtmosphere"/>
    <xs:enumeration value="economy"/>
    <xs:enumeration value="elevation"/>
    <xs:enumeration value="environment"/>
    <xs:enumeration value="geoscientificInformation"/>
    <xs:enumeration value="8_01-stratigraphy"/>
    <xs:enumeration value="8_02-paleontology"/>
    <xs:enumeration value="8_03-geochronology"/>
    <xs:enumeration value="8_04-sedimentology"/>
    <xs:enumeration value="8_05-magmaticPetrology"/>
    <xs:enumeration value="8_06-metamorphicPetrology"/>
    <xs:enumeration value="8_07-structureGeology"/>
    <xs:enumeration value="8_08-tectonics"/>
    <xs:enumeration value="8_09-geologicMapping"/>
    <xs:enumeration value="8_10-hydrogeology"/>
    <xs:enumeration value="8_11-engineeringGeologyGeotechnology"/>
    <xs:enumeration value="8_12-environmentalGeology"/>
    <xs:enumeration value="8_13-petroleumGeology"/>
    <xs:enumeration value="8_14-mathematicalGeoscience"/>
    <xs:enumeration value="8_15-marineGeology"/>
    <xs:enumeration value="8_16-mineralogy"/>
    <xs:enumeration value="8_17-gravimetricAndGravityExploration"/>
    <xs:enumeration value="8_18-geomagnetismAndMagneticExploration"/>
    <xs:enumeration value="8_19-geoelectricityAndElectricalExploration"/>
    <xs:enumeration value="8_20-seismologyAndSeismicExploration"/>
    <xs:enumeration value="8_21-nuclearGeophysicsandRadioactiveExploration"/>
    <xs:enumeration value="8_22-drillAndGeophysicalLogging"/>
    <xs:enumeration value="8_23-paleomagnetism"/>
    <xs:enumeration value="8_24-rockphysics"/>
    <xs:enumeration value="8_25-integratedgeophysics"/>
```

```
    <xs:enumeration value="8_26-geochemistry"/>
    <xs:enumeration value="8_27-remoteSensing"/>
    <xs:enumeration value="8_28-geomorphology"/>
    <xs:enumeration value="8_29-paleoclimatology"/>
    <xs:enumeration value="8_30-paleogeography"/>
    <xs:enumeration value="8_31-earthResource"/>
    <xs:enumeration value="8_32-geothermics"/>
    <xs:enumeration value="8_33-geoexploration"/>
    <xs:enumeration value="8_34-mining"/>
    <xs:enumeration value="8_35-economicalGeology"/>
    <xs:enumeration value="8_36-geologicalLiterature"/>
    <xs:enumeration value="8_37-planetaryGeology"/>
    <xs:enumeration value="8_38-biogeology"/>
    <xs:enumeration value="8_39-volcanology"/>
    <xs:enumeration value="8_40-forensicGeology"/>
    <xs:enumeration value="8_41-otherGeoscientificTopics"/>
    <xs:enumeration value="health"/>
    <xs:enumeration value="imageryBaseMapsEarthCover"/>
    <xs:enumeration value="intelligenceMilitary"/>
    <xs:enumeration value="inlandWaters"/>
    <xs:enumeration value="location"/>
    <xs:enumeration value="oceans"/>
    <xs:enumeration value="planningCadastre"/>
    <xs:enumeration value="society"/>
    <xs:enumeration value="structure"/>
    <xs:enumeration value="transportation"/>
    <xs:enumeration value="utilitiesCommunication"/>
    <xs:enumeration value="extraTerrestrial"/>
    <xs:enumeration value="disaster"/>
    <xs:enumeration value="dataScience"/>
    <xs:enumeration value="missing"/>
  </xs:restriction>
 </xs:simpleType>

</xs:schema>
```

References

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