RESQML Technical Reference Guide

for RESQML V2

RESQML Overview	The RESQML standard facilitates data exchange among the many software applications used along the E&P subsurface workflow, which helps promote interoperability and data integrity among these applications and improve workflow efficiency.
Version of Standard	V2.0
Abstract	This reference lists and defines all elements in the RESQML V2.0 data model, from which its content was generated.
Prepared by	Energistics and the RESQML SIG
Date published	15 September 2014
Document type	Technical Reference
Keywords:	standards, energy, data, information, process, reservoir model, shared earth model

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Document Information	
DOCUMENT VERSION	1.0
DATE	15 September 2014
Technical	e.g., Color: R: 210 G:124, B:50
Language	US English

Amendment History			
Version	**Date**	**Comment**	**By**
1.0	15 Sept 2014	First publication of the document for version 2.0 of RESQML.	Energistics and SIG

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1 Introduction

RESQML is an XML- and HDF5-based data-exchange standard that facilitates reliable, automated exchange of data among software packages used along the subsurface workflow. RESQML consists of a set of XML schemas (XSD files) and other standards-based technology, which developers implement into software packages. RESQML-compliant software can read and write this standard, common format, eliminating data incompatibility and the need for reformatting.

This document lists and defines all classes, complex types, elements and associations in the XML schemas that make up RESQML. Chapters 2-7 are generated from the RESQML V2.0 Enterprise Architecture (EA) project.

- For more details on how RESQML works, see the *RESQML Technical Usage Guide*.
- For an overview of the business value—how RESQML helps solve challenges in subsurface workflows—and a representative list of supported use cases, see the RESMQL Business Overview and Use Case Guide.

For links to these documents, see Section 1.4 (page 13).

1.1 Data Modeling with UML and EA

Beginning with V2.0, the RESQML Special Interest Group (SIG) began using the Unified Modeling Language™ (UML®), implemented with Enterprise Architecture (EA), a data modeling software tool, to design RESQML. The UML model has these uses:

- Source for generating the schemas (XSD files) that developers use to implement RESQML into a software package.
- Important resource for understanding RESQML. Developers can explore the class diagrams to get a quick understanding of organization and relationships, and drill down on objects to get definitions in context.
- Source of content for the *RESQML Technical Reference Guide* (this document). For convenience, the content of the UML model is also produced in this technical reference guide.

The EAP file containing the RESQML UML model is available as part of the RESQML resource set (see Section 1.4 (page 13)). A free UML reader, EA Lite, is available for download at http://www.sparxsystems.com/.

1.2 Audience, Purpose, and Scope

This document:

- Is for information technology (IT) professionals—programmers, developers, architects and others—who are implementing RESQML into a software package.
- Lists and defines all classes, complex types, elements, and associations in the XML schemas that make-up RESQML. Chapters 2-7 are generated from the RESQML V2.0 Enterprise Architecture (EA) project.
    - **Organization.** Each chapter describes one of the main packages that make up the EA project. Each chapter is organized by sub-package (if any), element types, and alpha-order within element type.

1.2.1 Audience Assumptions

This guide assumes that the reader has a good general understanding of programming and XML, and a basic understanding of the exploration and production (E&P) subsurface domain and workflow.

1.3 Documentation Conventions

Documentation for RESQML observes the conventions listed in the following table.

	Document/Resource	Description
1.	Mandatory Behavior	Mandatory behaviors are specified as business rules as shown in the example below. For more information, see the *RESQML Technical Usage Guide.* BUSINESS RULE: Array length is the number of cells in the grid or the blocked well.
2.	Document Hyperlinks: Internal	Though no special text-formatting convention is used: All section, page and figure numbers in this and all RESQML and Energistics documents are hyperlinks. The table of contents is also hyperlinked.

1.4 Resource Set

RESQML is a set of XML schemas (XSD files) freely available to download and use from the Energistics website.

To download the latest version of RESQML, go to the Energistics website at: http://www.energistics.org/reservoir/resqml-standards/current-standards.

The download includes all the resources listed in the following table and the table in Section 1.4.1 below. For easier access, the main documents are also available for direct download from the above link.

	Resource / Document	Description
1.	RESQML:XSD files	The RESQML package includes a readme file that details the contents of the download package.
2.	RESQML UML Data Model	The entire UML data model that developers and architects can explore for better understanding of data-objects, definitions, organization, and relationships. Developed using Enterprise Architecture (EA) modeling software (version 10), the UML model exists as an EA project (EAP) file. Information about EA, including a free EA Lite reader, is available at the Sparx Systems website, http://www.sparxsystems.com/. Included in the package when you download the RESQML standard.
3.	Examples	The download includes an example Energistics package containing a basic RESQML model. Additionally, new examples will be added. Check the link above for updates.
4.	*RESQML Business Overview and Use Case Guide* (Also available for direct download from above link.)	An introduction to RESMQL for domain/petro-technical professionals. Provides: • an overview of the business value and domain challenge that RESQML helps to solve. • a representative list of supported use cases.
5.	*RESQML Technical Usage Guide* (Also available for direct download from above link.)	Detailed explanation of RESQML key concepts and design intended for software/IT professionals. See also in download: Separate spreadsheet with spline equations related to Chapter 7 (20131223 RESQML Cubic

	Resource / Document	Description
		Splines.xlsx)
6.	*RESQML Technical Reference Guide (this document)* (Also available for direct download from above link.)	Lists and defines all packages, data-objects, elements, including related business rules. This document also identifies relationships between/among data-objects and highlights significant information about relationships (if any). Generated from the RESQML UML model.

1.4.1 Energistics Resource Set

The following documents are for use with all Energistics standards, including RESQML. These documents are included in the RESQML download. For easier access, the main documents are also available for direct download from: http://www.energistics.org/reservoir/resqml-standards/current-standards.

	Resource / Document	Description
1.	*Energistics commonv2 Technical Reference Guide* (Also available for direct download from above link.)	The commonv2 package contains elements that will be shared by all Energistics standards (e.g., RESQML and other MLs in the future). This document lists and defines packages, data-objects, elements, and relationships for the subset of commonv2 published in support of the current version of RESQML.
2.	*Energistics Packaging Conventions (EPC) Specification* (Also available for direct download from above link.)	Specifies the Energistics Packaging Conventions (EPC), which is the set of practices to store multiple files as a single entity for data transfer; this single entity is referred to as an Energistics package. EPC is an implementation of the Open Packaging Conventions (OPC), a container-file technology standard.
3.	*Energy Industry Profile of ISO 19115-1 (EIP)* (Also available for direct download from above link.)	An open, non-proprietary exchange standard for metadata used to document information resources, and in particular resources referenced to a geographic location, e.g., geospatial datasets and web services, physical resources with associated location, or mapping, interpretation, and modeling datasets. It is an ISO Conformance Level 1 profile of the published international standard ISO 19115-1:2014, which is the latest version of the mature conceptual specification ISO 19115:2003.
4.	*Energistics Unit of Measure Standard* (Also available for direct download from above link.)	A dictionary, grammar specification, and related documentation, which provide a consistent way to define, exchange, and convert between different units of measure. All Energistics standards (RESQML, WITSML, PRODML, etc.) must use this dictionary; other industry groups are also using it.
5.	*Energistics Coordinate Reference System Usage Guide* Status: DRAFT (available soon)	Explains how coordinate reference systems (CRS) work in Energistics data-exchange standards. Based on work and standards from the European Petroleum Survey Group (EPSG).

1.5 Model Overview

The RESQML UML model is implemented and organized in an Enterprise Architecture Project (EAP) file, grouped into packages as shown in **Figure 1-1** and explained below.

The UML model is available as part of the RESQML download. To view the model you need Enterprise Architecture or EA Lite, a free reader available from the company that develops EA, at its website http://www.sparxsystems.com/.

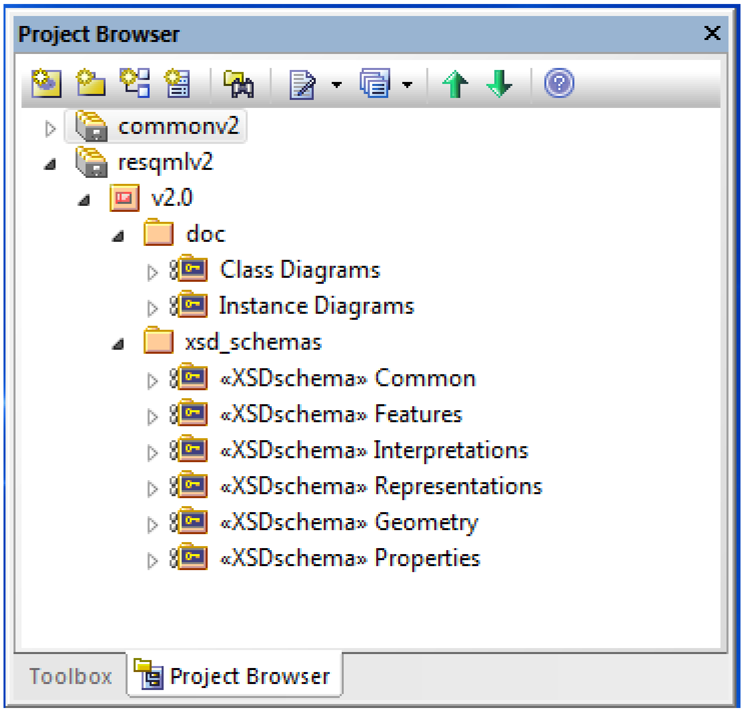

Figure 1-1—The RESQL EAP file contains the groupings shown here and explained in the text below.

Main packages of the RESQML UML model in EA are listed and described here.

commonv2. Contains the classes that are used by all Energistics standards, which includes classes to consistently define base data-objects and references, coordinate reference systems, and units of measure. For more information, see the *Energistics commonv2 Technical Reference Guide.* (For a link to this document, see Section 1.4.1 (page14).)

resqmlv2, contains:

- The **doc** class (folder), which contains packages for:
  - **Class Diagrams** for the schema packages listed below (with the diagrams labeled appropriately). The class diagrams illustrate the attributes, inheritances, and the other relationships of the packages in the xsd_schemas class (folder).
  - **Instance Diagrams** with various examples for you to explore.
- The **xsd_schema** class (folder), which contains these packages:
  - **Common.** Shared data-objects and related objects. These data-objects are shared across all packages in a RESQML project. Many objects are extensions of data-objects that appear in the shared Energistics-wide common package.
  - **Features.** Organized into two sub-packages—Geologic features and Technical features—this package contains all the classes that define the V2.0 business objects, which includes everything that needs to be defined to develop a subsurface model. Typical features include horizon, fault, geobody, wellbore, and many others.

- **Interpretations**. Contains all the classes that allow an interpreter to formalize his/her opinion of a feature. A typical example of interpretation is based on the opinion of the geometry of a feature. Other specific interpretation information may include the description of the throw of a fault, the horizon classification in a sequence stratigraphic approach, or the contacts in a structural model.
- **Representations**. Organized into four sub-packages—Structural, Grids, Seismic and Wells—this package contains all the supported topology, such as triangulation, fault stick, grids (2D grid, IJK grid, PEBI grid, unstructured grid, etc.
- **Geometry.** Geometry is attached to the indexable elements within a representation. Geometries are not RESQML top-level data-objects so cannot be transferred independently.
- **Properties**. Properties are attached to the indexable elements of a representation. Properties are designed to be transferred independently of a representation, and are top-level data-objects.

2 Common

Shared data-objects and related objects. These data-objects are shared across all packages in the RESQML schema.

2.1 AbstractLocal3dCrs

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defines a local 2D+1D coordinate reference system (CRS), by translation and rotation, whose origin is located at the (X,Y,Z) offset from the projected and vertical 2D+1D CRS.

The units of measure in XY follow the projected CRS. The units of measure of the third coordinate is determined in the depth or concrete type.

ArealRotation is a plane angle.

Defines a local 3D CRS, which is subject to the following restrictions:

- The projected 2D CRS must have orthogonal axes.
- The vertical 1D CRS must be chosen so that it is orthogonal to the plane defined by the projected 2D CRS.

As a consequence of the definition:

- The local CRS forms a Cartesian system of axes.
- The local areal axes are in the plane of the projected system.
- The local areal axes are orthogonal to each other.

This 3D system is semantically equivalent to a compound CRS composed of a local 2D areal system and a local 1D vertical system.

The labels associated with the axes on this local system are X, Y, Z or X, Y, T.

The relative orientation of the local Y axis with respect to the local X axis is identical to that of the global axes.

2.1.1 Attributes

Name	Data Type	Notes
ArealRotation	PlaneAngleMeasure	The rotation of the local Y axis relative to the projected Y axis. • A positive value indicates a clockwise rotation from the projected Y axis. • A negative value indicates a counter-clockwise rotation form the projected Y axis.
ProjectedAxisOrder	AxisOrder2d	Defines the coordinate system axis order of the global projected CRS when the projected CRS is an unknown CRS, else it must correspond to the axis order of the projected CRS.
ProjectedUom	LengthUom	Unit of measure of the associated projected CRS. When the projected CRS is known, it must be the same as the unit defined by the projected CRS.
VerticalUom	LengthUom	Unit of measure of the associated Vertical CRS. When the vertical CRS is known, it must be the same as the

Name	Data Type	Notes
		unit defined by the vertical CRS.
XOffset	double	The X location of the origin of the local areal axes relative to the projected CRS origin. BUSINESS RULE: The value MUST represent the first axis of the coordinate system. The unit of measure is defined by the unit of measure for the projected 2D CRS.
YOffset	double	The Y offset of the origin of the local areal axes relative to the projected CRS origin. BUSINESS RULE: The value MUST represent the second axis of the coordinate system. The unit of measure is defined by the unit of measure for the projected 2D CRS.
ZIncreasingDownward	boolean	Indicates that Z values correspond to depth values and are increasing downward, as opposite to elevation values increasing upward. When the vertical CRS is known, it must correspond to the axis orientation of the vertical CRS.
ZOffset	double	The Z offset of the origin of the local vertical axis relative to the vertical CRS origin. According to CRS type (depth or time) it corresponds to the depth or time datum. BUSINESS RULE: The value MUST represent the third axis of the coordinate system. The unit of measure is defined by the unit of measure for the vertical CRS.

Derived From: AbstractResqmlDataObject

Derived Classes: LocalDepth3dCrs, LocalTime3dCrs

2.1.2 Relationships

Role	Class	Cardinality
VerticalCrs	AbstractVerticalCrs	1..1
ProjectedCrs	AbstractProjectedCrs	1..1

2.2 AbstractResqmlDataObject

Stereotypes: XSDcomplexType

The parent class for all top-level elements in RESQML. Inherits from AbstractCitedDataObject in the commonV2 package of the model.

Derived From: AbstractCitedDataObject

Derived Classes: AbstractFeature, TimeSeries, AbstractLocal3dCrs, StratigraphicColumn, AbstractFeatureInterpretation, AbstractProperty, PropertySet, AbstractPropertyLookup, PropertyKind, AbstractRepresentation, RepresentationIdentitySet, LocalGridSet, GlobalChronostratigraphicColumn, WellboreMarker, MdDatum

2.2.1 Relationships

Role	Class	Cardinality
ExtraMetadata	NameValuePair	0..*

2.3 LocalDepth3dCrs

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defines a local depth coordinate system. The geometrical origin and location are defined by the elements of the base class AbstractLocal3dCRS. This CRS uses the units of measure of its projected and vertical CRS.

Derived From: AbstractLocal3dCrs

Derived Classes: (none)

Relationships: None

2.4 LocalTime3dCrs

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defines a local time coordinate system. The geometrical origin and location are defined by the elements of the base class AbstractLocal3dCRS. This CRS defines the time unit that the time-based geometries that refer to it will use.

2.4.1 Attributes

Name	Data Type	Notes
TimeUom	TimeUom	Defines the unit of measure of the third (time) coordinates, for the geometries that refer to it.

Derived From: AbstractLocal3dCrs

Derived Classes: (none)

Relationships: None

2.5 NameValuePair

Stereotypes: XSDcomplexType

Complementary optional metadata information, which may be added to any data-object to qualify it. This is a relatively simple mechanism that can be used to transfer information that is not critical but may improve user experience. For example, graphical attributes of elements such as color, could be transferred this way.

2.5.1 Attributes

Name	Data Type	Notes
Name	string	Name of the metadata information.

Name	Data Type	Notes
Value	string	Value of the metadata information.

Derived From: (none)

Derived Classes: (none)

Relationships: None

2.6 Point3d

Stereotypes: XSDcomplexType

Defines a point using coordinates in 3D space.

2.6.1 Attributes

Name	Data Type	Notes
Coordinate1	double	X coordinate
Coordinate2	double	Y coordinate
Coordinate3	double	Either Z or T coordinate

Derived From: (none)

Derived Classes: (none)

Relationships: None

2.7 ResqmlJaggedArray

Stereotypes: XSDcomplexType

Representation for an array of 1D variable length arrays. The representation consists of these two arrays:

- An aggregation of all the variable length arrays into a single dimensional array.
- The offsets into the other array, given by the sum of all the previous array lengths, including the current array.

Often referred to as a "list-of-lists" or "array-of-arrays" construction.

2.7.1 Attributes

Name	Data Type	Notes
Elements	AbstractValueArray	1D array of elements containing the aggregation of individual array data.
CumulativeLength	AbstractIntegerArray	1D array of cumulative lengths to the end of the current array. This is also equal to the index of the next element, i.e., the index in the elements array, for which the current variable length array begins.

Derived From: (none)

Derived Classes: (none)

Relationships: None

2.8 TimeIndex

Stereotypes: XSDcomplexType

Index into a time series. Used to specify time. (Not to be confused with time step.)

2.8.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	The index of the time in the time series.

Derived From: (none)

Derived Classes: (none)

2.8.2 Relationships

Role	Class	Cardinality
TimeSeries	TimeSeries	1..1

2.9 TimeSeries

Stereotypes: XSDcomplexType,XSDtopLevelElement

Stores an ordered list of times, for example, for time-dependent properties, geometries, or representations. It is used in conjunction with the time index to specify times for RESQML.

2.9.1 Attributes

Name	Data Type	Notes
Time	Timestamp	Individual times composing the series. The list ordering is used by the time index.

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

2.9.2 Relationships

Role	Class	Cardinality
TimeSeriesParentage	TimeSeriesParentage	0..1

2.10 TimeSeriesParentage

Stereotypes: XSDcomplexType

Indicates that a time series has the associated time series as a parent, i.e., that the series continues from the parent time series.

2.10.1 Attributes

Name	Data Type	Notes
HasOverlap	boolean	Used to indicate that a time series overlaps with its parent time series, e.g., as may be done for simulation studies, where the end state of one calculation is the initial state of the next.

Derived From: (none)

Derived Classes: (none)

2.10.2 Relationships

Role	Class	Cardinality
ParentTimeIndex	TimeIndex	1..1

2.11 Timestamp

Stereotypes: XSDcomplexType

XML dateTime, with an optional year offset to capture very long time intervals.

2.11.1 Attributes

Name	Data Type	Notes
DateTime	dateTime	A date, which can be represented according to the W3CDTF format.
YearOffset	long	Indicates that the dateTime attribute must be translated according to this value.

Derived From: (none)

Derived Classes: (none)

Relationships: None

3 Features

Features refer to something that has physical existence at some point during the exploration, development, production, or abandonment of a reservoir. For example: It can be a boundary, a rock volume, a basin area, but also extends to a drilled well, a drilling rig, an injected or produced fluid, or a 2D, 3D, or 4D seismic survey.

In RESQML, features are divided into these categories: geologic or technical.

Geologic Features. Objects that exist a priori, in the natural world, for example: the rock formations and how they are positioned with regard to each other; the fluids that are present before production; or the position of the geological intervals with respect to each. Some of these objects are static—such as geologic intervals---while others are dynamic—such as fluids: their properties, geometries, and quantities may change over time during the course of field production.

Technical Features. Objects that exist by the action of humans. Examples include: wells and all they may contain, seismic surveys (surface, permanent water bottom), or injected fluid volumes. Because the decision to deploy such equipment is the result of studies or decisions by humans, technical features are usually not subject to the same kind of large changes in interpretation as geologic features. However, they are still subject to measurement error and other sources of uncertainty, and so still can be considered as subject to “interpretation”.

3.1 <Main Package>

3.1.1 AbstractFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

Something that has physical existence at some point during the exploration, development, production or abandonment of a reservoir. For example: It can be a boundary, a rock volume, a basin area, but also extends to a drilled well, a drilling rig, an injected or produced fluid, or a 2D, 3D, or 4D seismic survey.

Features are divided into these categories: geologic or technical.

Derived From: AbstractResqmlDataObject

Derived Classes: AbstractTechnicalFeature, AbstractGeologicFeature

Relationships: None

3.2 Geologic Features

Objects that exist *a priori,* in the natural world, for example: the rock formations and how they are positioned with regard to each other; the fluids that are present before production; or the position of the geological intervals with respect to each. Some of these objects are static—such as geologic intervals---while others are dynamic—such as fluids; their properties, geometries, and quantities may change over time during the course of field production.

3.2.1 Phase

The enumeration of the possible rock fluid unit phases in a hydrostatic column.

The seal is considered here as a part (the coverage phase) of a hydrostatic column.

Name	Data Type	Notes
aquifer	External Reference	Volume of the hydrostatic column for which only the aqueous phase is mobile. Typically below the Pc(hydrocarbon-water)=0 free fluid surface.
gas cap	External Reference	Volume of the hydrostatic column for which only the gaseous phase is mobile. Typically above the

Name	Data Type	Notes
		Pc(gas-oil)=0 free fluid surface.
oil column	External Reference	Volume of the hydrostatic column for which only the oleic and aqueous phases may be mobile. Typically below the gas-oil Pc=0 free fluid surface.Pc(gas-oil)=0 free fluid surface.
seal	External Reference	Impermeable volume that provides the seal for a hydrostatic fluid column.

3.2.2 FluidContact

Enumerated values used to indicate a specific type of fluid boundary feature. See attributes below.

Name	Data Type	Notes
free water contact	External Reference	A surface defined by vanishing capillary pressure between the water and hydrocarbon phases.
gas oil contact	External Reference	A surface defined by vanishing capillary pressure between the gas and oil hydrocarbon phases.
gas water contact	External Reference	A surface defined by vanishing capillary pressure between the water and gas hydrocarbon phases.
seal	External Reference	Identifies a break in the hydrostatic column.
water oil contact	External Reference	A surface defined by vanishing capillary pressure between the water and oil hydrocarbon phases.

3.2.3 GeneticBoundaryKind

Enumerations used to indicate a specific type of genetic boundary feature. See attributes below. Note that a genetic boundary has a younger side and an older side.

Name	Data Type	Notes
geobody boundary	External Reference	An interface between a geobody and other geologic objects.
horizon	External Reference	An interface associated with a stratigraphic unit, which could be the top or bottom of the unit.

3.2.4 OrganizationKind

Enumerations used to indicate a specific type of organization. See attributes below.

Name	Data Type	Notes
earth model	External Reference	An organization composed of the other types of organizations listed here.
fluid	External Reference	A volume organization composed of fluid boundaries and phase units.
stratigraphic	External Reference	A volume organization composed of geologic features, such as geobodies, stratigraphic units, and boundaries.

Name	Data Type	Notes
structural	External Reference	A surface organization composed of geologic features, such as faults, horizons, and frontier boundaries.

3.2.5 TectonicBoundaryKind

Enumeration of the types of tectonic boundaries.

Name	Data Type	Notes
fault	External Reference	Fracture with displacement
fracture	External Reference	Fracture

3.2.6 AbstractGeologicFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

Objects that exist a priori, in the natural world, for example: the rock formations and how they are positioned with regard to each other; the fluids that are present before production; or the position of the geological intervals with respect to each. Some of these objects are static—such as geologic intervals---while others are dynamic—such as fluids; their properties, geometries, and quantities may change over time during the course of field production.

RESQML has these types of features: geologic and technical.

Derived From: AbstractFeature

Derived Classes: OrganizationFeature, BoundaryFeature, GeologicUnitFeature

Relationships: None

3.2.7 BoundaryFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

An interface between two geological objects, such as horizons and faults. It is a surface object.

Derived From: AbstractGeologicFeature

Derived Classes: TectonicBoundaryFeature, GeneticBoundaryFeature, FluidBoundaryFeature

Relationships: None

3.2.8 ChronostratigraphicRank

Stereotypes: XSDcomplexType

The chronostratigraphic ranking of “well known” stratigraphic unit features in the global chronostratigraphic column.

The ranks are organized from container to contained, e.g., (eon=1), (era=2), (period=3)

The units are ranked by using age as ordering criteria, from oldest to youngest.

These stratigraphic units have no associated interpretations or representations.

BUSINESS RULE: The name must reference a well-known stratigraphic unit feature (such as "Jurassic"), for example, from the International Commission on Stratigraphy (http://www.stratigraphy.org).

3.2.8.1 Attributes

Name	Data Type	Notes
Name	NameString	Name of the chrono rank such as "epoch, era, ..."

Derived From: (none)

Derived Classes: (none)

3.2.8.2 Relationships

Role	Class	Cardinality
Contains	StratigraphicUnitFeature	1..*

3.2.9 FluidBoundaryFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

A boundary (usually a plane) separating two fluid phases, such as a gas-oil contact (GOC), a water-oil contact (WOC), a gas-oil contact (GOC), or others. For types, see FluidContact.

3.2.9.1 Attributes

Name	Data Type	Notes
FluidContact	FluidContact	

Derived From: BoundaryFeature

Derived Classes: (none)

Relationships: None

3.2.10 GeneticBoundaryFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

A boundary between two units produced by a contrast between two deposits that occurred at two different geologic time periods. For types, see GeneticBoundaryKind.

3.2.10.1 Attributes

Name	Data Type	Notes
GeneticBoundaryKind	GeneticBoundaryKind	

Derived From: BoundaryFeature

Derived Classes: (none)

3.2.10.2 Relationships

Role	Class	Cardinality
AbsoluteAge	Timestamp	0..1

3.2.11 GeobodyFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

A volume of rock that is identified based on some specific attribute, like its mineral content or other physical characteristic. Unlike stratigraphic or phase units, there is no associated time or fluid content semantic. For types, see GeobodyKind.

Derived From: GeologicUnitFeature

Derived Classes: (none)

Relationships: None

3.2.12 GeologicUnitFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

A volume of rock located between one or more boundary features. The limiting boundary features should be genetic boundary features (i.e. should not be faults).

Derived From: AbstractGeologicFeature

Derived Classes: RockFluidUnitFeature, StratigraphicUnitFeature, GeobodyFeature

Relationships: None

3.2.13 GlobalChronostratigraphicColumn

Stereotypes: XSDcomplexType,XSDtopLevelElement

Chronological successions of some chronostratigraphic units organized into 1 to n chronological ranks.

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

3.2.13.1 Relationships

Role	Class	Cardinality
ChronostratigraphicColumnComponent	ChronostratigraphicRank	1..*

3.2.14 OrganizationFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

The explicit description of the relationships between geologic features, such as rock features (e.g., stratigraphic units, geobodies, phase unit) and boundary features (e.g., genetic, tectonic, and fluid boundaries). For types of organizations, see OrganizationKind.

3.2.14.1 Attributes

Name	Data Type	Notes
OrganizationKind	OrganizationKind	

Derived From: AbstractGeologicFeature

Derived Classes: (none)

Relationships: None

3.2.15 RockFluidUnitFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

A fluid phase plus one or more stratigraphic units. A unit may correspond to a pair of horizons that are not adjacent stratigraphically, e.g., a coarse zonation, and is often used to define the reservoir. For types, see Phase.

3.2.15.1 Attributes

Name	Data Type	Notes
Phase	Phase	

Derived From: GeologicUnitFeature

Derived Classes: (none)

3.2.15.2 Relationships

Role	Class	Cardinality
FluidBoundaryBottom	BoundaryFeature	1..1
FluidBoundaryTop	BoundaryFeature	1..1

3.2.16 StratigraphicUnitFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

A stratigraphic unit that can have a well-known (e.g., "Jurassic") chronostratigraphic top and chronostratigraphic bottom. These chronostratigraphic units have no associated interpretations or representations.

BUSINESS RULE: The name must reference a well-known chronostratigraphic unit (such as "Jurassic"), for example, from the International Commission on Stratigraphy (http://www.stratigraphy.org).

Derived From: GeologicUnitFeature

Derived Classes: (none)

3.2.16.1 Relationships

Role	Class	Cardinality
ChronostratigraphicBottom	GeneticBoundaryFeature	0..1
ChronostratigraphicTop	GeneticBoundaryFeature	0..1

3.2.17 TectonicBoundaryFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

A boundary caused by tectonic movement or metamorphism, such as a fault or a fracture. For types, see TectonicBoundaryKind.

3.2.17.1 Attributes

Name	Data Type	Notes
TectonicBoundaryKind	TectonicBoundaryKind	

Derived From: BoundaryFeature

Derived Classes: (none)

Relationships: None

3.3 Technical Features

Objects that exist by the action of humans. Examples include: Wells and all they may contain, seismic surveys (surface, permanent water bottom), or injected fluid volumes. Because the decision to lay such equipment is the result of studies or decisions by humans, Technical features are usually not subject to the same kind of large changes in interpretation as geologic features. However, they are still subject to measurement error and other sources of uncertainty, and so still can be considered as subject to "interpretation".

3.3.1 AbstractSeismicSurveyFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

An organization of seismic lines. For the context of RESQML, a seismic survey does not refer to any vertical dimension information, but only really at shot point locations or common midpoint gathers. The seismic traces, if needed by reservoir models, are transferred in an industry standard format such as SEGY.

RESQML supports these basic types of seismic surveys:

- seismic lattice (organization of the traces for the 3D acquisition and processing phases).
- seismic line (organization of the traces for the 2D acquisition and processing phases).

Additionally, these seismic lattices and seismic lines can be aggregated into sets.

Derived From: AbstractTechnicalFeature

Derived Classes: SeismicLatticeFeature, SeismicLineFeature, SeismicLineSetFeature, SeismicLatticeSetFeature

Relationships: None

3.3.2 AbstractTechnicalFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

Objects that exist by the action of humans. Examples include: wells and all they may contain, seismic surveys (surface, permanent water bottom), or injected fluid volumes. Because the decision to deploy such equipment is the result of studies or decisions by humans, technical features are usually not subject to the same kind of large changes in interpretation as geologic features. However, they are still subject to measurement error and other sources of uncertainty, and so still can be considered as subject to "interpretation".

RESQML has these types of features: geologic and technical.

Derived From: AbstractFeature

Derived Classes: AbstractSeismicSurveyFeature, FrontierFeature, WellboreFeature

Relationships: None

3.3.3 FrontierFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

Identifies a frontier or boundary in the earth model that is not a geological feature but an arbitrary geographic/geometric surface used to delineate the boundary of the model.

Derived From: AbstractTechnicalFeature

Derived Classes: (none)

Relationships: None

3.3.4 SeismicLatticeFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defined by two lateral ordered dimensions: inline (lateral), crossline (lateral and orthogonal to the inline dimension), which are fixed.

To specify its location, a seismic feature can be associated with the seismic coordinates of the points of a representation.

3.3.4.1 Attributes

Name	Data Type	Notes
CrosslineCount	positiveInteger	The count of crosslines in the 3D seismic survey.
CrosslineIndexIncrement	integer	The constant index increment between two consecutive crosslines of the 3D seismic survey.
FirstCrosslineIndex	integer	The index of the first crossline of the 3D seismic survey.
FirstInlineIndex	integer	The index of the first inline of the 3D seismic survey.
InlineCount	positiveInteger	The count of inlines in the 3D seismic survey.
InlineIndexIncrement	integer	The constant index increment between two consecutive inlines of the 3D seismic survey.

Derived From: AbstractSeismicSurveyFeature

Derived Classes: (none)

3.3.4.2 Relationships

Role	Class	Cardinality
IsPartOf	SeismicLatticeSetFeature	0..1

3.3.5 SeismicLatticeSetFeature

Stereotypes: XSDcomplexType

An unordered set of several seismic lattices. Generally, it has no direct interpretation or representation.

Derived From: AbstractSeismicSurveyFeature

Derived Classes: (none)

Relationships: None

3.3.6 SeismicLineFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defined by one lateral dimension: trace (lateral). Seismic trace of the 3D seismic survey.

To specify its location, the seismic feature can be associated with the seismic coordinates of the points of a representation.

3.3.6.1 Attributes

Name	Data Type	Notes
FirstTraceIndex	integer	The index of the first trace of the seismic line.
TraceCount	positiveInteger	The count of traces in the seismic line.
TraceIndexIncrement	integer	The constant index increment between two consecutive traces.

Derived From: AbstractSeismicSurveyFeature

Derived Classes: (none)

3.3.6.2 Relationships

Role	Class	Cardinality
IsPartOf	SeismicLineSetFeature	0..1

3.3.7 SeismicLineSetFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

An unordered set of several seismic lines. Generally, it has no direct interpretation or representation.

Derived From: AbstractSeismicSurveyFeature

Derived Classes: (none)

Relationships: None

3.3.8 WellboreFeature

Stereotypes: XSDcomplexType,XSDtopLevelElement

May refer to one of these:

wellbore. A unique, oriented path from the bottom of a drilled borehole to the surface of the earth. The path must not overlap or cross itself.

borehole. A hole excavated in the earth as a result of drilling or boring operations. The borehole may represent the hole of an entire wellbore (when no sidetracks are present), or a sidetrack extension. A borehole extends from an originating point (the surface location for the initial borehole or kickoff point for sidetracks) to a terminating (bottomhole) point.

sidetrack. A borehole that originates in another borehole as opposed to originating at the surface.

Derived From: AbstractTechnicalFeature

Derived Classes: (none)

3.3.8.1 Relationships

Role	Class	Cardinality
WitsmlWellbore	WitsmlWellboreReference	0..1

3.3.9 WitsmlWellboreReference

Stereotypes: XSDcomplexType

Reference to the WITSML wellbore that this wellbore feature is based on.

3.3.9.1 Attributes

Name	Data Type	Notes
WitsmlWell	DataObjectReference	
WitsmlWellbore	DataObjectReference	

Derived From: (none)

Derived Classes: (none)

Relationships: None

4 Geometry

This package describes the geometry classes of a RESQML model. In general, geometry is attached to a representation with either a finite extent or planes, which are infinite. However, when spatial locations need to be stored for specific elements in a representation, then this information is stored similarly to properties using property points.

4.1 AbstractGeometry

Stereotypes: XSDcomplexType

The base class for all geometric values, which is always associated with a representation.

Derived From: (none)

Derived Classes: AbstractPlaneGeometry, AbstractParametricLineGeometry, PointGeometry

4.1.1 Relationships

Role	Class	Cardinality
TimeIndex	TimeIndex	0..1
LocalCrs	AbstractLocal3dCrs	1..1

4.2 AbstractParametricLineArray

Stereotypes: XSDcomplexType

Defines an array of parametric lines.

The array size is obtained from context. In the current schema, this may be as simple as a 1D array (#Lines=count) or a 2D array #Lines = NIL x NJL for an IJK grid representation.

Derived From: (none)

Derived Classes: ParametricLineArray, ParametricLineFromRepresentationLatticeArray

Relationships: None

4.3 AbstractParametricLineGeometry

Stereotypes: XSDcomplexType

The abstract class for defining a single parametric line.

Derived From: AbstractGeometry

Derived Classes: ParametricLineFromRepresentationGeometry, ParametricLineGeometry

Relationships: None

4.4 AbstractPlaneGeometry

Stereotypes: XSDcomplexType

The abstract class for all geometric values defined by planes.

Derived From: AbstractGeometry

Derived Classes: TiltedPlaneGeometry, HorizontalPlaneGeometry

Relationships: None

4.5 AbstractPoint3dArray

Stereotypes: XSDcomplexType

The abstract class of 3D points implemented in a single fashion for the schema. Abstraction allows a variety of instantiations for efficiency or to implicitly provide additional geometric information about a data-object. For example, parametric points can be used to implicitly define a wellbore trajectory using an underlying parametric line, by the specification of the control points along the parametric line.

The dimensionality of the array of 3D points is based on context within an instance.

Derived From: (none)

Derived Classes: Point3dParametricArray, Point3dHdf5Array, Point3dFromRepresentationLatticeArray, Point3dZValueArray, Point3dLatticeArray, Point2dHdf5Array

Relationships: None

4.6 HorizontalPlaneGeometry

Stereotypes: XSDcomplexType

Defines the infinite geometry of a horizontal plane provided by giving its unique Z value.

4.6.1 Attributes

Name	Data Type	Notes
Coordinate	double	

Derived From: AbstractPlaneGeometry

Derived Classes: (none)

Relationships: None

4.7 ParametricLineArray

Stereotypes: XSDcomplexType

Defines an array of parametric lines of multiple kinds.

For more information, see the R*ESQML Technical Usage Guide*.

These are the documented parametric line kinds; see additional information below:

0 = vertical

1 = linear spline (piecewise linear)

2 = natural cubic spline

3 = tangential cubic spline

4 = Z linear cubic spline

5 = minimum-curvature spline

(-1) = null: no line

In general, a parametric line is unbounded so the interpolant in the first or last interval is used as an extrapolating function.

Special Cases:

(1) Natural cubic splines with only two control points reduce to linear interpolation.

(2) If required but not defined, tangent vectors at a spline knot are calculated from the control point data using a quadratic fit to the control point and the two adjacent control points (if internal) or, if at an edge, by a vanishing second derivative. This calculation reduces locally to a natural spline.

(3) If not expected but provided, then extraneous information is to be ignored, e.g., tangent vectors for linear splines.

Vertical:

(1) Control points are (X,Y,-).

(2) Parameter values are interpreted as depth => (X,Y,Z), where the depth to Z conversion depends on the vertical CRS direction.

Piecewise Linear:

(1) Control points are (P,X,Y,Z).

(2) Piecewise interpolation in (X,Y,Z) as a linear function of P.

Natural Cubic:

(1) Control points are (P,X,Y,Z).

(2) First and second derivatives at each knot are inferred from a quadratic fit to the two adjacent control points, if internal, or, if external knots, by specifying a vanishing second derivative.

Tangential Cubic and Minimum-Curvature.

(1) Control points are (P,X,Y,Z).

(2) Tangent vectors are (P,TX,TY,TZ). Tangent vectors are defined as the derivative of position with respect to the parameter. If the parameter is arc-length, then the tangent vectors are unit vectors, but not otherwise.

(3) Interpolating minimum-curvature basis functions obtained by a circular arc construction. This differs from the "drilling" algorithm in which the parameter must be arc length.

Z Linear Cubic:

(1) (X,Y) follow a natural cubic spline and Z follows a linear spline.

(2) Parametric values cannot be freely chosen but are instead defined to take on the values of 0,,,.N for a line with N intervals, N+1 control points.

(3) On export, to go from Z to P, the RESQML "software writer" first needs to determine the interval and then uses linearity in Z to determine P. For the control points, the P values are 0...N and for values of Z, other than the control points, non-integral values of P arise.

(4) On import, a RESQML "software reader" converts from P to Z using piecewise linear interpolation, and from P to X and Y using natural cubic spline interpolation. Other than the differing treatment of Z from X and Y, these are completely generic interpolation algorithms.

(5) The use of P instead of Z for interpolation allows support for over-turned reservoir structures and removes any apparent discontinuities in parametric derivatives at the spline knots.

4.7.1 Attributes

Name	Data Type	Notes
ControlPointParameters	AbstractDoubleArray	An optional array of explicit control point parameters for all of the control points on each of the parametric lines. Used only if control point parameters are present.

Name	Data Type	Notes
		The number of explicit control point parameters per line is given by the count of non-null parameters on each line. Described as a 1D array, the control point parameter array is divided into segments of length count, with null (NaN) values added to each segment to fill it up. Size = count x #Lines, e.g., 2D or 3D BUSINESS RULE: This count should be zero for vertical and Z linear cubic parametric lines. For all other parametric line kinds, there should be one control point parameter for each control point. NOTES: (1) Vertical parametric lines do not require control point parameters (2) Z linear cubic splines have implicitly defined parameters. For a line with N intervals (N+1 control points), the parametric values are P=0,...,N. BUSINESS RULE: The parametric values must be strictly monotonically increasing on each parametric line.
ControlPoints	AbstractPoint3dArray	An array of 3D points for all of the control points on each of the parametric lines. The number of control points per line is given by the KnotCount. Described as a 1D array, the control point array is divided into segments of length KnotCount, with null (NaN) values added to each segment to fill it up. Size = KnotCount x #Lines, e.g., 2D or 3D
KnotCount	positiveInteger	The first dimension of the control point, control point parameter, and tangent vector arrays for the parametric splines. The Knot Count is typically chosen to be the maximum number of control points, parameters or tangent vectors on any parametric line in the array of parametric lines.
LineKindIndices	AbstractIntegerArray	An array of integers indicating the parametric line kind. 0 = vertical 1 = linear spline 2 = natural cubic spline 3 = tangential cubic spline 4 = Z linear cubic spline 5 = minimum-curvature spline (-1) = null: no line Size = #Lines, e.g., (1D or 2D)
TangentVectors	AbstractPoint3dArray	An optional array of tangent vectors for all of the control points on each of the tangential cubic and minimum-curvature parametric lines. Used only if tangent vectors are present. The number of tangent vectors per line is given by the KnotCount for these spline types.

Name	Data Type	Notes
		Described as a 1D array, the tangent vector array is divided into segments of length Knot Count, with null (NaN) values added to each segment to fill it up. Size = Knot Count x #Lines, e.g., 2D or 3D BUSINESS RULE: For all lines other than the cubic and minimum-curvature parametric lines, this array should not appear. For these line kinds, there should be one tangent vector for each control point. If a tangent vector is missing, then it is computed in the same fashion as for a natural cubic spline. Specifically, to obtain the tangent at internal knots, the control points are fit by a quadratic function with the two adjacent control points. At edge knots, the second derivative vanishes.

Derived From: AbstractParametricLineArray

Derived Classes: (none)

4.7.2 Relationships

Role	Class	Cardinality
ParametricLineIntersections	ParametricLineIntersections	0..1

4.8 ParametricLineFromRepresentationGeometry

Stereotypes: XSDcomplexType

The parametric line extracted from an existing representation.

BUSINESS RULE: The supporting representation must have pillars or lines as indexable elements.

4.8.1 Attributes

Name	Data Type	Notes
LineIndiexOnSupportingRepresentation	nonNegativeInteger	The line index of the selected line in the supporting representation. For a column-layer grid, the parametric lines follow the indexing of the pillars.

Derived From: AbstractParametricLineGeometry

Derived Classes: (none)

4.8.2 Relationships

Role	Class	Cardinality
SupportingRepresentation	AbstractRepresentation	1..1

4.9 ParametricLineFromRepresentationLatticeArray

Stereotypes: XSDcomplexType

The lattice array of parametric lines extracted from an existing representation.

BUSINESS RULE: The supporting representation must have pillars or lines as indexable elements.

4.9.1 Attributes

Name	Data Type	Notes
LineIndicesOnSupportingRepresentation	IntegerLatticeArray	The line indices of the selected lines in the supporting representation. The index selection is regularly incremented from one node to the next node. BUSINESS RULE: The dimensions of the integer lattice array must be consistent with the dimensions of the supporting representation. For a column-layer grid, the parametric lines follow the indexing of the pillars. BUSINESS RULE: The start value of the integer lattice array must be the linearized index of the starting line. Example: iStart + ni * jStart in case of a supporting 2D grid.

Derived From: AbstractParametricLineArray

Derived Classes: (none)

4.9.2 Relationships

Role	Class	Cardinality
SupportingRepresentation	AbstractRepresentation	1..1

4.10 ParametricLineGeometry

Stereotypes: XSDcomplexType

Defines a parametric line of any kind.

For more information on the supported parametric lines, see ParametricLineArray.

4.10.1 Attributes

Name	Data Type	Notes
ControlPointParameters	AbstractDoubleArray	An optional array of explicit control point parameters for the control points on the parametric line. Used only if control point parameters are present. NOTES: (1) Vertical parametric lines do not require control point parameters. (2) Z linear cubic splines have implicitly defined parameters. For a line with N intervals (N+1 control

Name	Data Type	Notes
		points), the parametric values are P=0,...,N. BUSINESS RULE: If present, the size must match the number of control points. BUSINESS RULE: For vertical and Z linear cubic parametric lines, this count must be zero. For all other parametric line kinds, each control point must have one control point parameter. BUSINESS RULE: The parametric values must be strictly monotonically increasing on each parametric line. This is an optional array which should only be used if control point parameters are present. BUSINESS RILE: If present, the size must match the number of control points. BUSINESS RULE: This count should be zero for vertical and Z linear cubic parametric lines. For all other parametric line kinds there should be one control point parameter for each control point. Notes: (1) Vertical parametric lines do not require control point parameters (2) Z linear cubic splines have implicitly defined parameters. For a line with N intervals (N+1 control points), the parametric values are P=0,...,N. BUSINESS RULE: The parametric values must be strictly monotonically increasing on each parametric line.
ControlPoints	AbstractPoint3dArray	An array of 3D points for the control points on the parametric line.
KnotCount	positiveInteger	Number of spline knots in the parametric line.
LineKindIndex	integer	Integer indicating the parametric line kind 0 for vertical 1 for linear spline 2 for natural cubic spline 3 for cubic spline 4 for z linear cubic spline 5 for minimum-curvature spline (-1) for null: no line
TangentVectors	AbstractPoint3dArray	An optional array of tangent vectors for each control point on the cubic and minimum-curvature parametric lines. Used only if tangent vectors are present. If a tangent vector is missing, then it is computed in the same fashion as for a natural cubic spline. Specifically, to obtain the tangent at internal knots, the control points are fit by a quadratic function with the two adjacent control points. At edge knots, the second derivative vanishes.

Derived From: AbstractParametricLineGeometry

Derived Classes: (none)

Relationships: None

4.11 ParametricLineIntersections

Stereotypes: XSDcomplexType

Used to specify the intersections between parametric lines. This information is purely geometric and is not required for the evaluation of the parametric point locations on these lines. The information required for that purpose is stored in the parametric points array.

4.11.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of parametric line intersections. Must be positive.
IntersectionLinePairs	AbstractIntegerArray	Intersected line index pair for (line 1, line 2). Size = 2 x count
ParameterValuePairs	AbstractValueArray	Intersected line parameter value pairs for (line 1, line 2). Size = 2 x count

Derived From: (none)

Derived Classes: (none)

Relationships: None

4.12 Point2dHdf5Array

Stereotypes: XSDcomplexType

An array of explicit XY points stored as two coordinates in an HDF5 dataset. If needed, the implied Z coordinate is uniformly 0.

4.12.1 Attributes

Name	Data Type	Notes
Coordinates	Hdf5Dataset	Reference to an HDF5 2D dataset of XY points. The 2 coordinates are stored sequentially in HDF5, i.e., a multi-dimensional array of points is stored as a 2 x ... HDF5 array.

Derived From: AbstractPoint3dArray

Derived Classes: (none)

Relationships: None

4.13 Point3dFromRepresentationLatticeArray

Stereotypes: XSDcomplexType

A lattice array of points extracted from an existing representation.

BUSINESS RULE: The supporting representation must have nodes as indexable elements.

4.13.1 Attributes

Name	Data Type	Notes
NodeIndicesOnSupportingRepresentation	IntegerLatticeArray	The node indices of the selected nodes in the supporting representation. The index selection is regularly incremented from one node to the next node. BUSINESS RULE: The node indices must be consistent with the size of supporting representation.

Derived From: AbstractPoint3dArray

Derived Classes: (none)

4.13.2 Relationships

Role	Class	Cardinality
SupportingRepresentation	AbstractRepresentation	1..1

4.14 Point3dHdf5Array

Stereotypes: XSDcomplexType

An array of explicit XYZ points stored as three coordinates in an HDF5 dataset.

4.14.1 Attributes

Name	Data Type	Notes
Coordinates	Hdf5Dataset	Reference to an HDF5 3D dataset of XYZ points. The 3 coordinates are stored sequentially in HDF5, i.e., a multi-dimensional array of points is stored as a 3 x ... HDF5 array.

Derived From: AbstractPoint3dArray

Derived Classes: (none)

Relationships: None

4.15 Point3dLatticeArray

Stereotypes: XSDcomplexType

Describes a lattice array of points obtained by sampling from along a multi-dimensional lattice. Each dimension of the lattice can be uniformly or irregularly spaced.

4.15.1 Attributes

Name	Data Type	Notes
AllDimensionsAreOrthogonal	boolean	The optional element that indicates that the offset vectors for each direction are mutually orthogonal to each other. This meta-information is useful to remove any doubt of orthogonality in case of numerical precision issues. BUSINESS RULE: If you don't know it or if only one lattice dimension is given, do not provide this element.
Origin	Point3d	The origin location of the lattice given as XYZ coordinates.

Derived From: AbstractPoint3dArray

Derived Classes: (none)

4.15.2 Relationships

Role	Class	Cardinality
Offset	Point3dOffset	1..*

4.16 Point3dOffset

Stereotypes: XSDcomplexType

Defines the size and sampling in each dimension (direction) of the point 3D lattice array. Sampling can be uniform or irregular.

4.16.1 Attributes

Name	Data Type	Notes
Offset	Point3d	The direction of the axis of this lattice dimension. This is a relative offset vector instead of an absolute 3D point.
Spacing	AbstractDoubleArray	A lattice of N offset points is described by a spacing array of size N-1. The offset between points is given by the spacing value multiplied by the offset vector. For example, the first offset is 0. The second offset is the first spacing * offset. The second offset is (first spacing + second spacing) * offset, etc.

Derived From: (none)

Derived Classes: (none)

Relationships: None

4.17 Point3dParametricArray

Stereotypes: XSDcomplexType

A parametric specification of an array of XYZ points.

4.17.1 Attributes

Name	Data Type	Notes
Parameters	AbstractValueArray	A multi-dimensional array of parametric values that implicitly specifies an array of XYZ points. The parametric values provided in this data-object must be consistent with the parametric values specified in the referenced parametric line array. When constructing a column-layer grid geometry using parametric points, the array indexing follows the dimensionality of the coordinate lines x NKL, which is either a 2D or 3D array.
ParametricLineIndices	AbstractIntegerArray	An optional array of indices that map from the array index to the index of the corresponding parametric line. If this information is known from context, then this array is not needed. For example, in either of these cases: (1) If the mapping from array index to parametric line is 1:1. (2) If the mapping has already been specified, as with the pillar Index from the column-layer geometry of a grid. For example, when constructing a column-layer grid geometry using parametric lines, the array indexing follows the dimensionality of the coordinate lines.
TruncatedLineIndices	AbstractIntegerArray	A 2D array of line indices for use with intersecting parametric lines. Each record consists of a single line index, which indicates the array line that uses this truncation information, followed by the parametric line indices for each of the points on that line. For a non-truncated line, the equivalent record repeats the array line index NKL+1 times. Size = (NKL+1) x truncatedLineCount

Derived From: AbstractPoint3dArray

Derived Classes: (none)

4.17.2 Relationships

Role	Class	Cardinality
ParametricLines	AbstractParametricLineArray	1..1

4.18 Point3dZValueArray

Stereotypes: XSDcomplexType

An array of points defined by applying a Z value on top of an existing array of points, XYZ, where Z is ignored. Used in these cases:

- in 2D for defining geometry of one patch of a 2D grid representation.
- for extracting nodal geometry from one grid representation for use in another.

4.18.1 Attributes

Name	Data Type	Notes
ZValues	AbstractDoubleArray	The values for Z coordinates
SupportingGeometry	AbstractPoint3dArray	Geometry defining the X and Y coordinates.

Derived From: AbstractPoint3dArray

Derived Classes: (none)

Relationships: None

4.19 PointGeometry

Stereotypes: XSDcomplexType

The geometry of a set of points defined by their location in the local CRS, with optional seismic coordinates.

4.19.1 Attributes

Name	Data Type	Notes
Points	AbstractPoint3dArray	

Derived From: AbstractGeometry

Derived Classes: AbstractGridGeometry

4.19.2 Relationships

Role	Class	Cardinality
SeismicCoordinates	AbstractSeismicCoordinates	0..1

4.20 ThreePoint3d

Stereotypes: XSDcomplexType

List of three 3D points.

4.20.1 Attributes

Name	Data Type	Notes
Point3d	Point3d	

Derived From: (none)

Derived Classes: (none)

Relationships: None

4.21 TiltedPlaneGeometry

Stereotypes: XSDcomplexType

Describes the geometry of a tilted (or potentially not tilted) plane from three points.

Derived From: AbstractPlaneGeometry

Derived Classes: (none)

4.21.1 Relationships

Role	Class	Cardinality
Plane	ThreePoint3d	1..*

5 Interpretations

RESQML uses the definition of David Gawith, which explains an interpretation as a single consistent description of a feature. An interpretation is subjective and very strongly tied to the intellectual activity of the project team members. The initial curiosity and reasoning of the people on the project team initiates the early pre-screening campaign (remote sensing, surveys). They make hypotheses that consist of as many interpretations as necessary to describe the features (Gawith and Gutteridge 2007).

NOTE: The formal name is actually "feature-interpretation" and many of the class names use this full term. For conciseness of documentation, we use simply "interpretation" where this usage is not confusing.

RESQML now uses the term “interpretation” instead of alternative terms that were used in V1.1, such as “version” or “opinion".

Most of the information contained as attributes or enumerations in individual interpretation or organization interpretation will help users understand how the representations of the geological objects should be built or have been built, if the representation is already associated to the given interpretation.

5.1 ContactRelationship

The enumerations that specify the role of the contacts in a contact interpretation as described in the attributes below.

Name	Data Type	Notes
frontier feature to frontier feature		A contact between two frontier features to close a volume of interest.
genetic boundary to frontier feature		A linear contact between a genetic boundary interpretation and a frontier feature (horizon/frontier contact).
genetic boundary to genetic boundary		A linear contact between two genetic boundary interpretations (horizon/horizon contact).
genetic boundary to tectonic boundary		A linear contact between a genetic boundary interpretation and a tectonic boundary interpretation (horizon/fault contact).
stratigraphic unit to frontier feature		A surface contact between a stratigraphic unit interpretation and a frontier feature (contact closing a volume on a frontier feature that is a technical feature).
stratigraphic unit to stratigraphic unit		A surface contact between two stratigraphic unit interpretations (unit/unit contact).
tectonic boundary to frontier feature		A linear contact between a tectonic boundary interpretation and a frontier feature (fault/frontier contact).
tectonic boundary to genetic boundary		A linear contact between a tectonic boundary interpretation and a genetic boundary interpretation (fault/horizon contact).
tectonic boundary to tectonic boundary		A linear contact between two tectonic boundary interpretations (fault/fault contact).

5.2 ContactSide

Enumeration that specifies the location of the contacts, chosen from the attributes listed below. For example, if you specify contact between a horizon and a fault, you can specify if the contact is on the foot wall side or the hanging wall side of the fault, and if the fault is splitting both sides of a horizon or the older side only.

From Wikipedia: http://en.wikipedia.org/wiki/Foot_wall

Name	Data Type	Notes
footwall		The footwall side of the fault. See picture.
hanging wall		The hanging wall side of the fault. See picture.
north		For a vertical fault, specification of the north side.
south		For a vertical fault, specification of the south side.
east		For a vertical fault, specification of the east side.
west		For a vertical fault, specification of the west side.
younger		Indicates that a fault splits a genetic boundary on its younger side.
older		Indicates that a fault splits a genetic boundary on its older side.
both		Indicates that a fault splits both sides of a genetic feature.

5.3 Domain

Enumeration for the feature interpretation to specify if the measurement is in the seismic time or depth domain or if it is derived from a laboratory measurement.

Name	Data Type	Notes
depth		Position defined by measurements in the depth domain.
time		Position based on geophysical measurements in two-way time (TWT).
mixed		

5.4 ContactMode

An optional second qualifier that may be used when describing binary contact interpretation parts. (See also BinaryContactInterpretationPart and the *RESQML Technical Usage Guide*.)

Name	Data Type	Notes
extended		

Name	Data Type	Notes
proportional		
baselap		
erosion		

5.5 ContactVerb

Enumerations for the verbs that can be used to define the impact on the construction of the model of the geological event that created the binary contact.

Name	Data Type	Notes
splits		Specifies that the fault has opened a pair of fault lips in a horizon.
interrupts		Operation on which an “unconformable” genetic boundary interpretation interrupts another genetic boundary interpretation or a stratigraphic unit interpretation.
contains		(Precise use of this attribute to be determined during testing.)
conforms		Defines surface contact between two stratigraphic units.
erodes		Defines surface contact between two stratigraphic units.
stops at		Defines if a tectonic boundary interpretation stops at another tectonic boundary interpretation. Also used for genetic unit to frontier feature, fault to frontier feature, and sedimentary unit to frontier feature.
crosses		Defines if a tectonic boundary interpretation crosses another tectonic boundary interpretation.
includes		(Precise use of this attribute will be determined during testing.)

5.6 GeologicUnitComposition

Enumerations of the various compositions of geologic units.

Name	Data Type	Notes
intrusive mud		
intrusive clay		
organic		
evaporite salt		

Name	Data Type	Notes
evaporite non salt		
sedimentary siliclastic		
carbonate		
magmatic intrusive granitoid		
magmatic intrusive pyroclastic		
magmatic extrusive lava flow		
other chemichal rock		
sedimentary turbidite		

5.7 Geobody3dShape

The enumerated attributes of a horizon.

Name	Data Type	Notes
dyke		
silt		
dome		
sheeth		
diapir		
batholith		
channel		
delta		
dune		
fan		
reef		
wedge		

5.8 SequenceStratigraphySurface

The enumerated attributes of a horizon.

Name	Data Type	Notes
flooding		
ravinement		
maximum flooding		
transgressive		

5.9 DepositionMode

The enumerated attributes of a horizon.

Name	Data Type	Notes
proportional between top and bottom		
parallel to bottom		
parallel to top		
parallel to another boundary		

5.10 BoundaryRelation

The enumerated attributes of a horizon.

Name	Data Type	Notes
unconformable below and above		
conformable		If used uniquely, then it means the horizon is conformable above and below. If used with unconformity, then it means partial unconformity.
unconformable above		If used with conformable, then it means partial unconformity.
unconformable below		If used with conformable, then it means partial unconformity.

5.11 GeologicUnitMaterialImplacement

The enumerated attributes of a horizon.

Name	Data Type	Notes
autochtonous		
allochtonous		

5.12 OrderingCriteria

Enumeration used to specify the order of an abstract stratigraphic organization or a structural organization interpretation.

Name	Data Type	Notes
age		From youngest to oldest period (increasing age).
apparent depth		From surface to subsurface.
measured depth		From well head to wellbore bottom/total depth (TD).

5.13 ThrowKind

Enumerations that characterize the throw of the fault interpretation.

Name	Data Type	Notes
reverse		
normal		
thrust		
strike and slip		
scissor		
variable		

5.14 AbstractContactInterpretationPart

Stereotypes: XSDcomplexType

The parent class of an atomic, linear, or surface geologic contact description.

When the contact is between two surface representations (e.g., fault/fault, horizon/fault, horizon/horizon), then the contact is a line.

When the contact is between two volume representations (stratigraphic unit/stratigraphic unit), then the contact is a surface.

A contact interpretation can be associated with other contact interpretations in an organization interpretation.

To define a contact representation, you must first define a contact interpretation.

5.14.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	contact index
ContactRelationship	ContactRelationship	

Derived From: (none)

Derived Classes: MultipleContactInterpretationPart, BinaryContactInterpretationPart

5.14.2 Relationships

Role	Class	Cardinality
PartOf	AbstractFeatureInterpretation	0..1

5.15 AbstractFeatureInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The main class that contains all of the other feature interpretations included in this interpreted model.

5.15.1 Attributes

Name	Data Type	Notes
Domain	Domain	

Derived From: AbstractResqmlDataObject

Derived Classes: EarthModelInterpretation, GenericFeatureInterpretation, BoundaryFeatureInterpretation, GeologicUnitInterpretation, AbstractOrganizationInterpretation, WellboreInterpretation

5.15.2 Relationships

Role	Class	Cardinality
InterpretedFeature	AbstractFeature	1..1
HasOccuredDuring	TimeInterval	0..1

5.16 AbstractOrganizationInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The main class used to group features into meaningful units as a step in working towards the goal of building an earth model (the organization of all other organizations in RESQML).

An organization interpretation:

- Is typically comprised of one stack of its contained elements.
- May be built on other organization interpretations.

Typically contains:

- contacts between the elements of this stack among themselves.
- contacts between the stack elements and other organization elements.

Derived From: AbstractFeatureInterpretation

Derived Classes: AbstractStratigraphicOrganizationInterpretation, StructuralOrganizationInterpretation, RockFluidOrganizationInterpretation

5.16.1 Relationships

Role	Class	Cardinality
ContactInterpretation	AbstractContactInterpretationPart	0..*

5.17 AbstractStratigraphicOrganizationInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The main class that defines the relationships between the stratigraphic units and provides the stratigraphic hierarchy of the Earth.

BUSINESS RULE: A stratigraphic organization must be in a ranked order from a lower rank to an upper rank. For example, it is possible to find previous unit containment relationships between several ranks.

5.17.1 Attributes

Name	Data Type	Notes
OrderingCriteria	OrderingCriteria	

Derived From: AbstractOrganizationInterpretation

Derived Classes: StratigraphicOccurrenceInterpretation, StratigraphicColumnRankInterpretation

Relationships: None

5.18 BinaryContactInterpretationPart

Stereotypes: XSDcomplexType

The main class for data describing an opinion of the contact between two geologic feature-interpretations.

- A contact interpretation between two surface geological boundaries is usually a line.
- A contact interpretation between two volumes (rock feature-interpretation) is usually a surface.

This class allows you to build a formal sentence—in the pattern of subject-verb-direct object—which is used to describe the construction of a node, line, or surface contact. It is also possible to attach a primary and a secondary qualifier to the subject and to the direct object.

For more information, see the R*ESQML Technical Usage Guide*.

For example, one contact interpretation can be described by a sentence such as:

The interpreted fault named *F1 interp* on its hanging wall side splits the interpreted horizon named *H1 Interp* on both its sides.

Subject = *F1 Interp*, with qualifier "hanging wall side"

Verb = *splits*

Direct Object = *H1 Interp*, with qualifier "on both sides"

5.18.1 Attributes

Name	Data Type	Notes
DirectObject	ContactElementReference	Data-object reference (by UUID link) to a geologic feature-interpretation, which is the direct object of the sentence that defines how the contact was constructed.
Subject	ContactElementReference	Data-object reference (by UUID link) to a geologic feature-interpretation, which is the subject of the sentence that defines how the contact was constructed.
Verb	ContactVerb	

Derived From: AbstractContactInterpretationPart

Derived Classes: (none)

Relationships: None

5.19 BoundaryFeatureInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The main class for data describing an opinion of a surface feature between two volumes.

BUSINESS RULE: The data-object reference (of type "interprets") must reference only a boundary feature.

Derived From: AbstractFeatureInterpretation

Derived Classes: FaultInterpretation, HorizonInterpretation, GeobodyBoundaryInterpretation

Relationships: None

5.20 ContactElementReference

Stereotypes: XSDcomplexType

A reference to either a geologic feature interpretation or a frontier feature.

BUSINESS RULE: The content type of the corresponding data-object reference must be a geological feature-interpretation or a frontier feature.

5.20.1 Attributes

Name	Data Type	Notes
SecondaryQualifier	ContactMode	
Qualifier	ContactSide	

Derived From: DataObjectReference

Derived Classes: (none)

Relationships: None

5.21 EarthModelInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

An earth model interpretation has a specific role: it gathers a maximum of one of each of these other organization interpretations: structural organization interpretation, stratigraphic organization interpretation, and/or fluid organization interpretation.

BUSINESS RULE: An earth model Interpretation interprets only an earth model feature.

Derived From: AbstractFeatureInterpretation

Derived Classes: (none)

5.21.1 Relationships

Role	Class	Cardinality
StratigraphicOccurrences	StratigraphicOccurrenceInterpretation	0..*
StratigraphicColumn	StratigraphicColumn	0..1
Structure	StructuralOrganizationInterpretation	0..1
Fluid	RockFluidOrganizationInterpretation	0..1

5.22 FaultInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A type of boundary feature, this class contains the data describing an opinion about the characterization of the fault, which includes the attributes listed below.

5.22.1 Attributes

Name	Data Type	Notes
IsListric	boolean	Indicates if the normal fault is listric or not. BUSINESS RULE: Must be present if the fault is normal. Must not be present if the fault is not normal.
MaximumThrow	LengthMeasure	
MeanAzimuth	PlaneAngleMeasure	
MeanDip	PlaneAngleMeasure	

Derived From: BoundaryFeatureInterpretation

Derived Classes: (none)

5.22.2 Relationships

Role	Class	Cardinality
ThrowInterpretation	FaultThrow	0..*

5.23 FaultThrow

Stereotypes: XSDcomplexType

Identifies the characteristic of the throw of a fault interpretation.

5.23.1 Attributes

Name	Data Type	Notes
Throw	ThrowKind	

Derived From: (none)

Derived Classes: (none)

5.23.2 Relationships

Role	Class	Cardinality
HasOccuredDuring	TimeInterval	0..1

5.24 GenericFeatureInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

An interpretation of a feature that is not specialized. For example, use it when the specialized type of the associated feature is not known.

Derived From: AbstractFeatureInterpretation

Derived Classes: (none)

Relationships: None

5.25 GeobodyBoundaryInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A type of boundary feature, this class identifies if the boundary is a geobody and the type of the boundary.

5.25.1 Attributes

Name	Data Type	Notes
BoundaryRelation	BoundaryRelation	

Derived From: BoundaryFeatureInterpretation

Derived Classes: (none)

Relationships: None

5.26 GeobodyInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A type of rock feature, this class identifies if a rock feature is a geobody with any qualifications on the interpretation of the geobody.

5.26.1 Attributes

Name	Data Type	Notes
Geobody3dShape	Geobody3dShape	

Derived From: GeologicUnitInterpretation

Derived Classes: (none)

Relationships: None

5.27 GeologicUnitInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The main class for data describing an opinion of a volume-based geologic feature or unit.

5.27.1 Attributes

Name	Data Type	Notes
GeologicUnitComposition	GeologicUnitComposition	
GeologicUnitMaterialImplacement	GeologicUnitMaterialImplacement	

Derived From: AbstractFeatureInterpretation

Derived Classes: StratigraphicUnitInterpretation, GeobodyInterpretation, RockFluidUnitInterpretation

Relationships: None

5.28 GeologicUnitInterpretationIndex

Stereotypes: XSDcomplexType

Element that lets you index and order rock feature interpretations. For possible ordering criteria, see OrderingCriteria.

5.28.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	An index value associated to an instance of this type interpretation, given a specific ordering criteria.

Derived From: (none)

Derived Classes: (none)

5.28.2 Relationships

Role	Class	Cardinality
Unit	GeologicUnitInterpretation	1..1

5.29 HorizonInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

An interpretation of a horizon, which optionally provides stratigraphic information.

5.29.1 Attributes

Name	Data Type	Notes
BoundaryRelation	BoundaryRelation	
SequenceStratigraphySurface	SequenceStratigraphySurface	

Derived From: BoundaryFeatureInterpretation

Derived Classes: (none)

Relationships: None

5.30 HorizonInterpretationIndex

Stereotypes: XSDcomplexType

Element that lets you index and order horizon interpretations. For possible ordering criteria, see OrderingCriteria.

5.30.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	An index value associated to an instance of this type of interpretation, given a specific ordering criteria
StratigraphicRank	nonNegativeInteger	Number of the stratigraphic rank on which the previous indices have been defined.

Derived From: (none)

Derived Classes: (none)

5.30.2 Relationships

Role	Class	Cardinality
Horizon	HorizonInterpretation	1..1

5.31 MultipleContactInterpretationPart

Stereotypes: XSDcomplexType

Describes multiple interface contacts of geologic feature-interpretations (compared to a binary contact). A composition of several contact interpretations.

5.31.1 Attributes

Name	Data Type	Notes
With	nonNegativeInteger	Indicates a list of binary contacts (by their UUIDs) that participate in this multiple contact.

Derived From: AbstractContactInterpretationPart

Derived Classes: (none)

Relationships: None

5.32 RockFluidOrganizationInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Interpretation of the fluid organization units.

Derived From: AbstractOrganizationInterpretation

Derived Classes: (none)

5.32.1 Relationships

Role	Class	Cardinality
RockFluidUnitIndex	RockFluidUnitInterpretationIndex	1..1

5.33 RockFluidUnitInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A type of rock fluid feature-interpretation , this class identifies a rock fluid feature by its phase.

5.33.1 Attributes

Name	Data Type	Notes
Phase	Phase	

Derived From: GeologicUnitInterpretation

Derived Classes: (none)

Relationships: None

5.34 RockFluidUnitInterpretationIndex

Stereotypes: XSDcomplexType

An element that allows ordering of fluid feature interpretations in a fluid organization interpretation.

5.34.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	Index of the fluid feature interpretation.

Derived From: (none)

Derived Classes: (none)

5.34.2 Relationships

Role	Class	Cardinality
RockFluidUnit	GeologicUnitInterpretation	1..1

5.35 StratigraphicColumn

Stereotypes: XSDcomplexType,XSDtopLevelElement

A global interpretation of the stratigraphy, which can be made up of several ranks of stratigraphic unit interpretations.

BUSINESS RULE: All stratigraphic column rank interpretations that make up a stratigraphic column must be ordered by age.

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

5.35.1 Relationships

Role	Class	Cardinality
Ranks	StratigraphicColumnRankInterpretation	1..*

5.36 StratigraphicColumnRankInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A global hierarchy containing an ordered list of stratigraphic unit interpretations.

5.36.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	

Derived From: AbstractStratigraphicOrganizationInterpretation

Derived Classes: (none)

5.36.2 Relationships

Role	Class	Cardinality
StratigraphicUnits	StratigraphicUnitInterpretationIndex	1..*

5.37 StratigraphicOccurrenceInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A local Interpretation—it could be along a well, on a 2D map, or on a 2D section or on a part of the global volume of an earth model—of a succession of rock feature elements.

The stratigraphic column rank interpretation composing a stratigraphic occurrence can be ordered by the criteria listed in OrderingCriteria.

BUSINESS RULE: A representation of a stratigraphic occurrence interpretation can be a wellbore marker or a wellbore frame.

Derived From: AbstractStratigraphicOrganizationInterpretation

Derived Classes: (none)

5.37.1 Relationships

Role	Class	Cardinality
IsOccurrenceOf	StratigraphicColumnRankInterpretation	0..1
GeologicUnitIndex	GeologicUnitInterpretationIndex	0..*

5.38 StratigraphicUnitInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Interpretation of a stratigraphic unit which includes the knowledge of the top, the bottom, and the deposition mode.

5.38.1 Attributes

Name	Data Type	Notes
DepositionMode	DepositionMode	BUSINESS RULE: The deposition mode for a geological unit MUST be consistent with the boundary relations of a genetic boundary. If it is not, then the boundary relation declaration is retained.
MaxThickness	LengthMeasure	
MinThickness	LengthMeasure	

Derived From: GeologicUnitInterpretation

Derived Classes: (none)

Relationships: None

5.39 StratigraphicUnitInterpretationIndex

Stereotypes: XSDcomplexType

Element that lets you index and order stratigraphic unit interpretations. For possible ordering criteria, see OrderingCriteria.

5.39.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	An index value associated to an instance of this type of interpretation, given a specific ordering criteria.

Derived From: (none)

Derived Classes: (none)

5.39.2 Relationships

Role	Class	Cardinality
Unit	StratigraphicUnitInterpretation	1..1

5.40 StructuralOrganizationInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

One of the main types of RESQML organizations, this class gathers boundary interpretations (e.g., horizons and faults) plus frontier features and their relationships (contacts interpretations), which when taken together define the structure of a part of the earth.

5.40.1 Attributes

Name	Data Type	Notes
OrderingCriteria	OrderingCriteria	

Derived From: AbstractOrganizationInterpretation

Derived Classes: (none)

5.40.2 Relationships

Role	Class	Cardinality
Faults	FaultInterpretation	0..*
Horizons	HorizonInterpretationIndex	0..*
Sides	AbstractFeatureInterpretation	0..*
TopFrontier	AbstractFeatureInterpretation	0..*
BottomFrontier	AbstractFeatureInterpretation	0..*

5.41 TimeInterval

Stereotypes: XSDcomplexType

Geological time during which a geological event (e.g., deposition, erosion, fracturation, faulting, intrusion) occurred.

BUSINESS RULE: All rock features that are present in the global chronostratigraphic column feature must have a time interval.

Derived From: (none)

Derived Classes: (none)

5.41.1 Relationships

Role	Class	Cardinality
ChronoBottom	GeneticBoundaryFeature	1..1
ChronoTop	GeneticBoundaryFeature	1..1

5.42 WellboreInterpretation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Contains the data describing an opinion of a borehole. This interpretation is relative to one particular well trajectory.

5.42.1 Attributes

Name	Data Type	Notes
IsDrilled	boolean	Used to indicate that this wellbore has been, or is being, drilled, as opposed to planned wells. One wellbore feature may have multiple wellbore interpretations. IsDrilled=TRUE is used for updated drilled trajectories. IsDrilled=FALSE is used for planned trajectories.

Derived From: AbstractFeatureInterpretation

Derived Classes: (none)

Relationships: None

6 Properties

Individual property values are attached to a single type of element in the representation, either its topological elements, such as nodes or cells, or larger elements such as the entire representation or large parts of it, through patches and sub-representations.

Each property value is also associated with a single property type, which provides global semantics about the meaning of these values. Property values can also be associated with facets, which provide additional context for the values.

It is very common in subsurface/earth modeling workflows to follow the evolution of some property values through time or to consider them together as a group of property values attached to the same or different representations and property types. To capture this information, RESQML provides the notion of time series and a property group.

When spatial locations (geometry) need to be stored for specific elements in a representation, then property points are used.

6.1 Facet

Enumerations of the type of qualifier that applies to a property type to provide additional context about the nature of the property. For example, may include conditions, direction, qualifiers, or statistics. Facets are used in RESQML to provide qualifiers to existing property types, which minimizes the need to create specialized property types.

Name	Data Type	Notes
conditions		Indicates condition of how the property was acquired, e.g., distinguishing surface condition of a fluid compared to reservoir conditions.
direction		Indicates that the property is directional. Common values are X, Y, or Z for vectors; I, J, or K for properties on a grid; or tensorial coordinates, e.g., XX or IJ. For example, vertical permeability vs. horizontal permeability.
netgross		Indicates that the property is of kind net or gross, i.e., indicates that the spatial support of a property is averaged only over the net rock or all of the rock. rock or all of the rock.
qualifier		Used to capture any other context not covered by the other facet types listed here.
statistics		Indicates values such as minimum, maximum, average, etc.
what		Indicates the element that is measured, for example, the concentration of a mineral.

6.2 TimeSetKind

Indicates that the collection of properties shares this time relationship, if any.

Name	Data Type	Notes
single time		Indicates that the collection contains only property values associated with a single time index, i.e., time identity can be ascertained from the time index itself,

Name	Data Type	Notes
		without knowledge of the time.
equivalent times		Indicates that the collection of properties is at equivalent times, e.g., a 4D seismic data set and a reservoir simulation model at comparable times. For a more specific relationship, select single time.
not a time set		Indicates that the property collection is not related by time.

6.3 ResqmlPropertyKind

Enumeration of the standard set of RESQML property kinds.

Name	Data Type	Notes
absorbed dose	TypeEnum	The amount of energy absorbed per mass.
acceleration linear	TypeEnum	
activity (of radioactivity)	TypeEnum	A measure of the radiation being emitted.
amount of substance	TypeEnum	Molar amount of a substance.
amplitude	TypeEnum	Amplitude of the acoustic signal recorded. It is not a physical property, only a value.
angle per length	TypeEnum	
angle per time	TypeEnum	The angular velocity. The rate of change of an angle.
angle per volume	TypeEnum	
angular acceleration	TypeEnum	
area	TypeEnum	
area per area	TypeEnum	A dimensionless quantity where the basis of the ratio is area.
area per volume	TypeEnum	
attenuation	TypeEnum	A logarithmic, fractional change of some measure, generally power or amplitude, over a standard range. This is generally used for frequency attenuation over an octave.
attenuation per length	TypeEnum	
azimuth	TypeEnum	Angle between the North and the projection of the normal to the horizon surface estimated on a local area of the interface.
bubble point pressure	TypeEnum	The pressure at which the first gas bubble appears while decreasing pressure on a fluid sample.
bulk modulus	TypeEnum	Bulk modulus, K

Name	Data Type	Notes
capacitance	TypeEnum	
categorical	TypeEnum	The abstract supertype of all enumerated string properties.
cell length	TypeEnum	distance from cell face center to cell face center in the specified direction, DI, DJ, DK
charge density	TypeEnum	
chemical potential	TypeEnum	
code	TypeEnum	A discrete code.
compressibility	TypeEnum	
concentration of B	TypeEnum	molar concentration of a substance.
conductivity	TypeEnum	
continuous	TypeEnum	The abstract supertype of all floating point properties.
cross section absorption	TypeEnum	
current density	TypeEnum	
Darcy flow coefficient	TypeEnum	
data transmission speed	TypeEnum	used primarily for computer transmission rates.
delta temperature	TypeEnum	Delta temperature refers to temperature differences. For non-zero offset temperature scales, Fahrenheit and Celsius, the conversion formulas are different than for absolute temperatures.
density	TypeEnum	
depth	TypeEnum	The perpendicular measurement downward from a surface. Also, the direct linear measurement from the point of viewing usually from front to back.
diffusion coefficient	TypeEnum	
digital storage	TypeEnum	
dimensionless	TypeEnum	A dimensionless quantity is the ratio of two dimensional quantities. The quantity types are not apparent from the basic dimensionless class, but may be apparent in variations - such as area per area, volume per volume, or mass per mass.
dip	TypeEnum	In the azimuth direction, Angle between an horizon plane and an estimated plane on a local area of the interface.
discrete	TypeEnum	The abstract supertype of all integer properties.

Name	Data Type	Notes
dose equivalent	TypeEnum	
dose equivalent rate	TypeEnum	
dynamic viscosity	TypeEnum	
electric charge	TypeEnum	
electric conductance	TypeEnum	
electric current	TypeEnum	
electric dipole moment	TypeEnum	
electric field strength	TypeEnum	
electric polarization	TypeEnum	
electric potential	TypeEnum	
electrical resistivity	TypeEnum	
electrochemical equivalent	TypeEnum	An electrochemical equivalent differs from molarity in that the valence (oxidation reduction potential) of the element is also considered.
electromagnetic moment	TypeEnum	
energy length per area	TypeEnum	
energy length per time area temperature	TypeEnum	
energy per area	TypeEnum	
energy per length	TypeEnum	
equivalent per mass	TypeEnum	
equivalent per volume	TypeEnum	
exposure (radioactivity)	TypeEnum	
fluid volume	TypeEnum	Volume of fluid
force	TypeEnum	
force area	TypeEnum	
force length per length	TypeEnum	
force per force	TypeEnum	A dimensionless quantity where the basis of the ratio is force.
force per length	TypeEnum	
force per volume	TypeEnum	

Name	Data Type	Notes
formation volume factor	TypeEnum	Ratio of volumes at subsurface and surface conditions
frequency	TypeEnum	
frequency interval	TypeEnum	An octave is a doubling of a frequency.
gamma ray API unit	TypeEnum	This class is defined by the API, and is used for units of gamma ray log response.
heat capacity	TypeEnum	
heat flow rate	TypeEnum	
heat transfer coefficient	TypeEnum	PRESSURE PER VELOCITY PER AREA
illuminance	TypeEnum	
index	TypeEnum	Serial ordering
irradiance	TypeEnum	
isothermal compressibility	TypeEnum	
kinematic viscosity	TypeEnum	
Lambda Rho	TypeEnum	Product of Lame constant and density, LR
Lame constant	TypeEnum	Lame constant, Lambda
length	TypeEnum	
length per length	TypeEnum	A dimensionless quantity where the basis of the ratio is length.
length per temperature	TypeEnum	
length per volume	TypeEnum	
level of power intensity	TypeEnum	
light exposure	TypeEnum	
linear thermal expansion	TypeEnum	
luminance	TypeEnum	
luminous efficacy	TypeEnum	
luminous flux	TypeEnum	
luminous intensity	TypeEnum	
magnetic dipole moment	TypeEnum	
magnetic field strength	TypeEnum	

Name	Data Type	Notes
magnetic flux	TypeEnum	
magnetic induction	TypeEnum	
magnetic permeability	TypeEnum	
magnetic vector potential	TypeEnum	
mass	TypeEnum	M/L2T
mass attenuation coefficient	TypeEnum	
mass concentration	TypeEnum	A dimensionless quantity where the basis of the ratio is mass.
mass flow rate	TypeEnum	
mass length	TypeEnum	
mass per energy	TypeEnum	
mass per length	TypeEnum	M /L4T
mass per time per area	TypeEnum	
mass per time per length	TypeEnum	
mass per volume per length	TypeEnum	
mobility	TypeEnum	
modulus of compression	TypeEnum	
molar concentration	TypeEnum	molar concentration of a substance.
molar heat capacity	TypeEnum	
molar volume	TypeEnum	
mole per area	TypeEnum	
mole per time	TypeEnum	
mole per time per area	TypeEnum	
moment of force	TypeEnum	
moment of inertia	TypeEnum	
moment of section	TypeEnum	
momentum	TypeEnum	
Mu Rho	TypeEnum	Product of Shear modulus and density, MR

Name	Data Type	Notes
net to gross ratio	TypeEnum	Ratio of net rock volume to gross rock volume, NTG
neutron API unit	TypeEnum	
nonDarcy flow coefficient	TypeEnum	
operations per time	TypeEnum	
parachor	TypeEnum	
per area	TypeEnum	
per electric potential	TypeEnum	
per force	TypeEnum	
per length	TypeEnum	
per mass	TypeEnum	
per volume	TypeEnum	
permeability length	TypeEnum	
permeability rock	TypeEnum	
permeability thickness	TypeEnum	Product of permeability and thickness
permeance	TypeEnum	
permittivity	TypeEnum	
pH	TypeEnum	The pH is a class that measures the hydrogen ion concentration (acidity).
plane angle	TypeEnum	
Poisson ratio	TypeEnum	Poisson's ratio, Sigma
pore volume	TypeEnum	Volume of the Pore Space of the Rock
porosity	TypeEnum	porosity
potential difference per power drop	TypeEnum	
power	TypeEnum	
power per volume	TypeEnum	
pressure	TypeEnum	
pressure per time	TypeEnum	
pressure squared	TypeEnum	

Name	Data Type	Notes
pressure squared per force time per area	TypeEnum	
pressure time per volume	TypeEnum	
productivity index	TypeEnum	
property multiplier	TypeEnum	Unitless multiplier to apply to any property
quantity	TypeEnum	The abstract supertype of all floating point properties with a unit of measure.
quantity of light	TypeEnum	
radiance	TypeEnum	
radiant intensity	TypeEnum	
relative permeability	TypeEnum	Ratio of phase permeability, which is a function of saturation, to the rock permeability
relative power	TypeEnum	A dimensionless quantity where the basis of the ratio is power.
relative time	TypeEnum	A dimensionless quantity where the basis of the ratio is time.
reluctance	TypeEnum	
resistance	TypeEnum	
resistivity per length	TypeEnum	
RESQML root property	TypeEnum	The abstract supertype of all properties. This property does not have a parent.
Rock Impedance	TypeEnum	Acoustic impedance, Ip, Is
rock permeability	TypeEnum	See "permeability rock"
rock volume	TypeEnum	Rock Volume
saturation	TypeEnum	Ratio of phase fluid volume to pore volume
second moment of area	TypeEnum	
shear modulus	TypeEnum	Shear modulus, Mu
solid angle	TypeEnum	
solution gas-oil ratio	TypeEnum	Ratio of solution gas volume to oil volume at reservoir conditions
specific activity (of radioactivity)	TypeEnum	
specific energy	TypeEnum	

Name	Data Type	Notes
specific heat capacity	TypeEnum	
specific productivity index	TypeEnum	
specific volume	TypeEnum	
surface density	TypeEnum	
temperature per length	TypeEnum	
temperature per time	TypeEnum	
thermal conductance	TypeEnum	
thermal conductivity	TypeEnum	
thermal diffusivity	TypeEnum	
thermal insulance	TypeEnum	
thermal resistance	TypeEnum	
thermodynamic temperature	TypeEnum	
thickness	TypeEnum	Distance measured in a volume between two surfaces (e.g., geological top boundary and geological bottom boundary of a geological unit).
time	TypeEnum	
time per length	TypeEnum	
time per volume	TypeEnum	
transmissibility	TypeEnum	Volumetric flux per unit area per unit pressure drop for unit viscosity fluid
unit productivity index	TypeEnum	
unitless	TypeEnum	The abstract supertype of all floating point properties with NO unit of measure. In order to allow the unit information to be required for all continuous properties, the special unit of measure of "NONE" has been assigned to all children of this class. In addition, the special dimensional class of "0" has been assigned to all children of this class.
vapor oil-gas ratio	TypeEnum	Ratio of oil vapor volume to gas volume at reservoir conditions
velocity	TypeEnum	
volume	TypeEnum	
volume flow rate	TypeEnum	

Name	Data Type	Notes
volume length per time	TypeEnum	
volume per area	TypeEnum	
volume per length	TypeEnum	
volume per time per area	TypeEnum	
volume per time per length	TypeEnum	
volume per time per time	TypeEnum	
volume per time per volume	TypeEnum	
volume per volume	TypeEnum	A dimensionless quantity where the basis of the ratio is volume.
volumetric heat transfer coefficient	TypeEnum	
volumetric thermal expansion	TypeEnum	
work	TypeEnum	
Young modulus	TypeEnum	Young's modulus, E

6.4 ResqmlUom

Because of the list of valid RESQML units of measure is quite long, it has been moved to Appendix A (page 154).

6.5 AbstractBooleanArray

Stereotypes: XSDcomplexType

Generic representation of an array of Boolean values. Each derived element provides a specialized implementation to allow specific optimization of the representation.

Derived From: AbstractValueArray

Derived Classes: BooleanArrayFromDiscretePropertyArray, BooleanHdf5Array, BooleanConstantArray, BooleanArrayFromIndexArray

Relationships: None

6.6 AbstractDoubleArray

Stereotypes: XSDcomplexType

Generic representation of an array of double values. Each derived element provides specialized implementation to allow specific optimization of the representation.

Derived From: AbstractValueArray

Derived Classes: DoubleHdf5Array, DoubleConstantArray, DoubleLatticeArray

Relationships: None

6.7 AbstractIntegerArray

Stereotypes: XSDcomplexType

Generic representation of an array of integer values. Each derived element provides specialized implementation to allow specific optimization of the representation.

Derived From: AbstractValueArray

Derived Classes: IntegerRangeArray, IntegerLatticeArray, IntegerHdf5Array, IntegerConstantArray, IntegerArrayFromBooleanMaskArray

Relationships: None

6.8 AbstractProperty

Stereotypes: XSDcomplexType,XSDtopLevelElement

Base class for storing all property values on representations, except current geometry location.

Values attached to a given element can be either a scalar or a vector. The size of the vector is constant on all elements, and it is assumed that all elements of the vector have identical property types and share the same unit of measure.

6.8.1 Attributes

Name	Data Type	Notes
IndexableElement	IndexableElements	
Count	positiveInteger	Number of elements in a 1D list of properties. When used in a multi-dimensional array, count is always the fastest.
RealizationIndex	nonNegativeInteger	Optional element indicating the realization index (metadata). Used if the property is the result of a multi-realization process.
TimeStep	nonNegativeInteger	Indicates that the property is the output of a specific time step from a flow simulator. Time step is metadata that makes sense in the context of a specific simulation run, and should not be confused with the time index.

Derived From: AbstractResqmlDataObject

Derived Classes: AbstractValuesProperty, PointsProperty

6.8.2 Relationships

Role	Class	Cardinality
TimeIndex	TimeIndex	0..1
SupportingRepresentation	AbstractRepresentation	1..1
LocalCrs	AbstractLocal3dCrs	0..1
PropertyKind	AbstractPropertyKind	1..1

6.9 AbstractPropertyKind

Stereotypes: XSDcomplexType

The super class for all property kinds, i.e., the local property kinds and the standard/Energistics property kind.

Derived From: (none)

Derived Classes: LocalPropertyKind, StandardPropertyKind

Relationships: None

6.10 AbstractPropertyLookup

Stereotypes: XSDcomplexType,XSDtopLevelElement

Generic representation of a property lookup table. Each derived element provides specific lookup methods for different data types.

Derived From: AbstractResqmlDataObject

Derived Classes: StringTableLookup, DoubleTableLookup

Relationships: None

6.11 AbstractValueArray

Stereotypes: XSDcomplexType

Generic representation of an array of numeric, Boolean, and string values. Each derived element provides specialized implementation for specific content types or for optimization of the representation.

Derived From: (none)

Derived Classes: AbstractBooleanArray, AbstractIntegerArray, StringHdf5Array, AbstractDoubleArray

Relationships: None

6.12 AbstractValuesProperty

Stereotypes: XSDcomplexType,XSDtopLevelElement

Base class for property values. Each derived element provides specific property values, including point property in support of geometries.

Derived From: AbstractProperty

Derived Classes: CategoricalProperty, DiscreteProperty, CommentProperty, ContinuousProperty

6.12.1 Relationships

Role	Class	Cardinality
PatchOfValues	PatchOfValues	1..*
Facet	PropertyKindFacet	0..*

6.13 BooleanArrayFromDiscretePropertyArray

Stereotypes: XSDcomplexType

An array of Boolean values that is explicitly defined by indicating which indices in the array are either true or false. This class is used to represent very sparse true or false data, based on a discrete property.

6.13.1 Attributes

Name	Data Type	Notes
Value	integer	Integer to match for the value to be considered true

Derived From: AbstractBooleanArray

Derived Classes: (none)

6.13.2 Relationships

Role	Class	Cardinality
Property	DiscreteProperty	1..1

6.14 BooleanArrayFromIndexArray

Stereotypes: XSDcomplexType

An array of Boolean values defined by specifying explicitly which indices in the array are either true or false. This class is used to represent very sparse true or false data.

6.14.1 Attributes

Name	Data Type	Notes
Indices	AbstractIntegerArray	Array of integer indices. BUSINESS RULE: Must be non-negative.
Count	positiveInteger	Total number of Boolean elements in the array. This number is different from the number of indices used to represent the array.
IndexIsTrue	boolean	Indicates whether the specified elements are true or false.

Derived From: AbstractBooleanArray

Derived Classes: (none)

Relationships: None

6.15 BooleanConstantArray

Stereotypes: XSDcomplexType

Represents an array of Boolean values where all values are identical. This an optimization for which an array of explicit Boolean values is not required.

6.15.1 Attributes

Name	Data Type	Notes
Value	boolean	Value inside all the elements of the array.

Name	Data Type	Notes
Count	positiveInteger	Size of the array.

Derived From: AbstractBooleanArray

Derived Classes: (none)

Relationships: None

6.16 BooleanHdf5Array

Stereotypes: XSDcomplexType

Array of Boolean values provided explicitly by an HDF5 dataset.

6.16.1 Attributes

Name	Data Type	Notes
Values	Hdf5Dataset	Reference to an HDF5 array of values.

Derived From: AbstractBooleanArray

Derived Classes: (none)

Relationships: None

6.17 CategoricalProperty

Stereotypes: XSDcomplexType,XSDtopLevelElement

Information specific to one categorical property. Contains discrete integer.

This type of property is associated either as:

- an internally stored index to a string through a lookup mapping.
- an internally stored double to another double value through an explicitly provided table.

Derived From: AbstractValuesProperty

Derived Classes: (none)

6.17.1 Relationships

Role	Class	Cardinality
Lookup	AbstractPropertyLookup	1..1

6.18 CommentProperty

Stereotypes: XSDcomplexType,XSDtopLevelElement

Information specific to one comment property.

Used to capture comments or annotations associated with a given element type in a data-object, for example, associating comments on the specific location of a well path.

6.18.1 Attributes

Name	Data Type	Notes
Language	string	Identify the language (e.g., US English or French) of the string. It is recommended that language names conform to ISO 639.

Derived From: AbstractValuesProperty

Derived Classes: (none)

Relationships: None

6.19 ContinuousProperty

Stereotypes: XSDcomplexType,XSDtopLevelElement

Most common type of property used for storing rock or fluid attributes; all are represented as doubles.

So that the value range can be known before accessing all values, the min and max values of the range are also stored.

BUSINESS RULE: It also contains a unit of measure, which can be different from the unit of measure of its property type, but it must be convertible into this unit.

6.19.1 Attributes

Name	Data Type	Notes
MinimumValue	double	The minimum of the associated property values. BUSINESS RULE: There can be only one value per number of elements.
UOM	ResqmlUom	Unit of measure for the property.
MaximumValue	double	The maximum of the associated property values. BUSINESS RULE: There can be only one value per number of elements.

Derived From: AbstractValuesProperty

Derived Classes: (none)

Relationships: None

6.20 DiscreteProperty

Stereotypes: XSDcomplexType,XSDtopLevelElement

Contains discrete integer values; typically used to store any type of index.

So that the value range can be known before accessing all values, it also stores the minimum and maximum value in the range.

6.20.1 Attributes

Name	Data Type	Notes
MinimumValue	integer	The minimum of the associated property values. BUSINESS RULE: There can only be one value per number of elements.
MaximumValue	integer	The maximum of the associated property values. BUSINESS RULE: There can only be one value per number of elements.

Derived From: AbstractValuesProperty

Derived Classes: (none)

Relationships: None

6.21 DoubleConstantArray

Stereotypes: XSDcomplexType

Represents an array of double values where all values are identical. This an optimization for which an array of explicit double values is not required.

6.21.1 Attributes

Name	Data Type	Notes
Value	double	Values inside all the elements of the array.
Count	positiveInteger	Size of the array.

Derived From: AbstractDoubleArray

Derived Classes: (none)

Relationships: None

6.22 DoubleHdf5Array

Stereotypes: XSDcomplexType

An array of double values provided explicitly by an HDF5 dataset.

By convention, the null value is NaN.

6.22.1 Attributes

Name	Data Type	Notes
Values	Hdf5Dataset	Reference to an HDF5 array of doubles.

Derived From: AbstractDoubleArray

Derived Classes: (none)

Relationships: None

6.23 DoubleLatticeArray

Stereotypes: XSDcomplexType

Represents an array of doubles based on an origin and a multi-dimensional offset. The offset is based on a linearization of a multi-dimensional offset.

If count(i) is the number of elements in the dimension i and offset(i) is the offset in the dimension i, then:

globalOffsetInNDimension = startValue+ ni*offset(n) + n_1i*count(n)*offset(n-1) + ... + 0i*count(n)*count(n-1)*....count(1)*offset(0)

6.23.1 Attributes

Name	Data Type	Notes
StartValue	double	Value representing the global start for the lattice.

Derived From: AbstractDoubleArray

Derived Classes: (none)

6.23.2 Relationships

Role	Class	Cardinality
Offset	DoubleConstantArray	1..*

6.24 DoubleLookup

Stereotypes: XSDcomplexType

(key,value) pairs for a lookup table.

6.24.1 Attributes

Name	Data Type	Notes
Key	double	Input to a table lookup.
Value	double	Output from a table lookup.

Derived From: (none)

Derived Classes: (none)

Relationships: None

6.25 DoubleTableLookup

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defines a function for table lookups. For example, used for linear interpolation, such as PVT.

Used for categorical property, which also may use StringTableLookup.

Derived From: AbstractPropertyLookup

Derived Classes: (none)

6.25.1 Relationships

Role	Class	Cardinality
Value	DoubleLookup	1..*

6.26 IntegerArrayFromBooleanMaskArray

Stereotypes: XSDcomplexType

One-dimensional array of integer values obtained from the true elements of the Boolean mask.

6.26.1 Attributes

Name	Data Type	Notes
TotalIndexCount	positiveInteger	Total number of integer elements in the array. This number is different from the number of Boolean mask values used to represent the array.
Mask	AbstractBooleanArray	Boolean mask. A true element indicates that the index is included on the list of integer values.

Derived From: AbstractIntegerArray

Derived Classes: (none)

Relationships: None

6.27 IntegerConstantArray

Stereotypes: XSDcomplexType

Represents an array of integer values where all values are identical. This an optimization for which an array of explicit integer values is not required.

6.27.1 Attributes

Name	Data Type	Notes
Value	integer	Values inside all the elements of the array.
Count	positiveInteger	Size of the array.

Derived From: AbstractIntegerArray

Derived Classes: (none)

Relationships: None

6.28 IntegerHdf5Array

Stereotypes: XSDcomplexType

Array of integer values provided explicitly by an HDF5 dataset. The null value must be explicitly provided in the NullValue attribute of this class.

6.28.1 Attributes

Name	Data Type	Notes
Values	Hdf5Dataset	Reference to an HDF5 array of integers or doubles.
NullValue	integer	

Derived From: AbstractIntegerArray

Derived Classes: (none)

Relationships: None

6.29 IntegerLatticeArray

Stereotypes: XSDcomplexType

Represents an array of integers based on an origin and a multi-dimensional offset. The offset is based on a linearization of a multi-dimensional offset.

If count(i) is the number of elements in the dimension i and offset(i) is the offset in the dimension i, then:

globalOffsetInNDimension = startValue+ ni*offset(n) + n_1i*count(n)*offset(n-1) + ... + 0i*count(n)*count(n-1)*....count(1)*offset(0)

6.29.1 Attributes

Name	Data Type	Notes
StartValue	integer	Value representing the global start for the lattice: i.e., iStart + jStart*ni + kStart*ni*nj

Derived From: AbstractIntegerArray

Derived Classes: (none)

6.29.2 Relationships

Role	Class	Cardinality
Offset	IntegerConstantArray	1..*

6.30 IntegerRangeArray

Stereotypes: XSDcomplexType

Defines an array as a range of integers. The range is defined by an initial value and a count defining the size of the range.

6.30.1 Attributes

Name	Data Type	Notes

Name	Data Type	Notes
Value	integer	Start value for the range. End value is start+count-1.
Count	positiveInteger	Size of the array.

Derived From: AbstractIntegerArray

Derived Classes: (none)

Relationships: None

6.31 LocalPropertyKind

Stereotypes: XSDcomplexType

A property kind that is not a standard/Energistics one. It is created and defined by the writer. This property kind must be a specialization of one of the standard/Energistics property kinds.

Derived From: AbstractPropertyKind

Derived Classes: (none)

6.31.1 Relationships

Role	Class	Cardinality
LocalPropertyKind	PropertyKind	1..1

6.32 PatchOfPoints

Stereotypes: XSDcomplexType

A patch of points. In RESQML, a patch is a set or range of one kind of topological elements used to define part of a data-object, such as grids or structural data-objects.

6.32.1 Attributes

Name	Data Type	Notes
RepresentationPatchIndex	nonNegativeInteger	Optional patch index used to attach properties to a specific patch of the indexable elements.
Points	AbstractPoint3dArray	Geometric points (or vectors) to be attached to the specified indexable elements.

Derived From: (none)

Derived Classes: (none)

Relationships: None

6.33 PatchOfValues

Stereotypes: XSDcomplexType

A patch of values. See also Patch.

6.33.1 Attributes

Name	Data Type	Notes
RepresentationPatchIndex	nonNegativeInteger	Patch index used to attach properties to a specific patch of the indexable elements.
Values	AbstractValueArray	Values to be attached to the indexable elements.

Derived From: (none)

Derived Classes: (none)

Relationships: None

6.34 PointsProperty

Stereotypes: XSDcomplexType,XSDtopLevelElement

Represents the geometric information that should *not* be used as representation geometry, but should be used in another context where the location or geometrical vectorial distances are needed.

Derived From: AbstractProperty

Derived Classes: (none)

6.34.1 Relationships

Role	Class	Cardinality
PatchOfPoints	PatchOfPoints	1..*

6.35 PropertyKind

Stereotypes: XSDcomplexType,XSDtopLevelElement

A description of a property name relative to a standard definition. For example, you may specify if the property kind is abstract, the dictionary in which the property is unique, and the representative unit of measure.

6.35.1 Attributes

Name	Data Type	Notes
NamingSystem	anyURI	The name of the dictionary within which the property is unique. This also defines the name of the controlling authority. Use a URN of the form "urn:x-resqml:domainOrEmail:dictionaryName". An example public dictionary: "urn:resqml:energistics.org:RESQML" assigned to values defined by ResqmlPropertyKind. An example corporate dictionary:

Name	**Data Type**	**Notes**
		"urn:resqml:slb.com:product-x". An example personal dictionary: "urn:resqml:first.last@mycompany.com:my.first.dictionary". The purpose of this scheme is to generate a unique name. Parsing for semantics is not intended.
IsAbstract	boolean	A value of true indicates that the property kind is abstract and an instance of property values must not represent this kind. A value of false indicates otherwise (i.e., that an instance of property values may represent this kind).
RepresentativeUom	ResqmlUom	Generally matches the base for conversion, except where multiple classes have the same underlying dimensional analysis. In this case, the representative unit may provide additional information about the underlying concept of the class. For example, "area per volume" has the same dimensional analysis as "per length", but it specifies a representative unit of "m2/m3" instead of "1/m".

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

6.35.2 Relationships

Role	**Class**	**Cardinality**
ParentPropertyKind	AbstractPropertyKind	1..1

6.36 PropertyKindFacet

Stereotypes: XSDcomplexType

Qualifiers for property values, which allow users to semantically specialize a property without creating a new property kind.

For the list of enumerations, see Facet.

6.36.1 Attributes

Name	**Data Type**	**Notes**
Value	string	Property facet value.
Facet	Facet	Facet of the property kind (see the enumeration)

Derived From: (none)

Derived Classes: (none)

Relationships: None

6.37 PropertySet

Stereotypes: XSDcomplexType,XSDtopLevelElement

A set of properties collected together for a specific purpose. For example, a property set can be used to collect all the properties corresponding to the simulation output at a single time, or all the values of a single property type for all times.

6.37.1 Attributes

Name	Data Type	Notes
TimeSetKind	TimeSetKind	
HasSinglePropertyKind	boolean	If true, indicates that the collection contains only property values associated with a single property kind.
HasMultipleRealizations	boolean	If true, indicates that the collection contains properties with defined realization indices.

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

6.37.2 Relationships

Role	Class	Cardinality
	PropertySet	1..1
Properties	AbstractProperty	1..*

6.38 StandardPropertyKind

Stereotypes: XSDcomplexType

A standard property kind is defined in the Energistics catalog. It has an unique name.

6.38.1 Attributes

Name	Data Type	Notes
Kind	ResqmlPropertyKind	

Derived From: AbstractPropertyKind

Derived Classes: (none)

Relationships: None

6.39 StringHdf5Array

Stereotypes: XSDcomplexType

Used to store explicit string values, i.e., values that are not double, boolean or integers. The datatype of the values will be identified by means of the HDF5 API.

6.39.1 Attributes

Name	Data Type	Notes
Values	Hdf5Dataset	Reference to HDF5 array of integer or double

Derived From: AbstractValueArray

Derived Classes: (none)

Relationships: None

6.40 StringLookup

Stereotypes: XSDcomplexType

Defines an element inside a string-to-integer lookup table.

6.40.1 Attributes

Name	Data Type	Notes
Key	integer	The corresponding integer value. This value is used in HDF5 instead of the string value. The value of null integer value must be reserved for NULL. The size of this value is constrained by the size of the format used in HDF5.
Value	string	A string value. Output from the lookup table.

Derived From: (none)

Derived Classes: (none)

Relationships: None

6.41 StringTableLookup

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defines an integer-to-string lookup table, for example, stores facies properties, where a facies index is associated with a facies name. .

Used for categorical properties, which also may use a double table lookup.

Derived From: AbstractPropertyLookup

Derived Classes: (none)

6.41.1 Relationships

Role	Class	Cardinality
Value	StringLookup	1..*

7 Representations

A representation refers to a digital description of a feature or interpretation. For example, currently in RESQML, a horizon interpretation may be represented by a point set, a set of triangulated surfaces, or a set of orthogonal grids.

A representation has two distinct and complementary roles in RESQML:

- It is an important component of the feature/interpretation/representation/property knowledge hierarchy where it corresponds to a 3D modeling expression of a feature that was initialized at the beginning of a business process. For example, the same horizon feature-interpretation can have a 2D grid representation or a triangulated set representation.
- It supports the geometry and properties of data-objects in RESQML. The geometry of a representation is contained within the representation, while properties may be attached to the representation. Each property is “attached” to the indexable elements of a representation, which may be as simple as the nodes on a single triangulated surface or as complex as the cell, nodes, faces, pillars, coordinate lines, columns, etc., for a 3D grid.

The representation package is organized into a main package with the main representation classes and sub-packages for:

- Grids
- Structural
- Wells
- Seismic

7.1 <Main Package>

7.1.1 IndexableElements

Indexable elements for the different representations. The indexing of each element depends upon the specific representation.

To order and reference the elements of a representation, RESQML makes extensive use of the concept of indexing. Both one-dimensional and multi-dimensional arrays of elements are used. So that all elements may be referenced in a consistent and uniform fashion, each multi-dimensional index must have a well-defined 1D index.

Attributes below identify the IndexableElements, though not all elements apply to all types of representations.

Indexable elements are used to:

- attach geometry and properties to a representation.
- identify portions of a representation when expressing a representation identity.
- construct a sub-representation from an existing representation.

See the RESQML Overview Guide for the table of indexable elements and the representations to which they apply.

Name	Data Type	Notes
cells	External Reference	
column edges	External Reference	
columns	External Reference	

Name	Data Type	Notes
contacts	External Reference	
coordinate lines	External Reference	
edges	External Reference	
edges per column	External Reference	
enumerated elements	External Reference	
faces	External Reference	
faces per cell	External Reference	
interval edges	External Reference	Count = NKL (Column Layer Grids, only)
intervals	External Reference	
I0	External Reference	Count = NI (IJK Grids, only)
I0 edges	External Reference	Count = NIL (IJK Grids, only)
J0	External Reference	Count = NJ (IJK Grids, only)
J0 edges	External Reference	Count = NJL (IJK Grids, only)
layers	External Reference	Count = NK (Column Layer Grids, only)
nodes	External Reference	
nodes per cell	External Reference	
nodes per edge	External Reference	
nodes per face	External Reference	
patches	External Reference	
pillars	External Reference	
regions	External Reference	
representation	External Reference	
subnodes	External Reference	
triangles	External Reference	

7.1.2 IdentityKind

Enumeration of the identity kinds for the element identities (ElementIdentity).

Name	Data Type	Notes
colocation	External Reference	A set of (sub)representations is collocated if there is bijection between the simple elements of all of the participating (sub)representations. This definition

Name	Data Type	Notes
		implies there is the same number of simple elements. **NOTE:** The geometric location of each set of simple elements mapped through the bijection is intended to be identical even if the numeric values of the associated geometries differ, i.e., due to loss of spatial resolution.
previous colocation	External Reference	The participating (sub)representations were collocated at some time in the geologic past—but not necessarily in the present day earth model.
equivalence	External Reference	A set of (sub)representations is equivalent if there is a map giving an association between some of the simple topological elements of the participating (sub)representations.
previous equivalence	External Reference	The participating (sub)representations were equivalent at some time in the geologic past—but not necessarily in the present day earth model.

7.1.3 AbstractRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The parent class of all specialized digital descriptions, which may provide a representation of a feature interpretation or a technical feature. It may be either of these:

- based on a topology and contains the geometry of this digital description.
- based on the topology or the geometry of another representation.

Not all representations require a defined geometry. For example, it is not required for block-centered grids or wellbore frames. For representations without geometry, a software writer may provide null (NaN) values in the local 3D CRS, which is mandatory.

TimeIndex is provided to describe time-dependent geometry.

Derived From: AbstractResqmlDataObject

Derived Classes: SubRepresentation, RedefinedGeometryRepresentation, RepresentationSetRepresentation, GridConnectionSetRepresentation, AbstractGridRepresentation, AbstractSurfaceRepresentation, PolylineRepresentation, PolylineSetRepresentation, PointSetRepresentation, WellboreTrajectoryRepresentation, WellboreFrameRepresentation, DeviationSurveyRepresentation

7.1.3.1 Relationships

Role	Class	Cardinality
RepresentedInterpretation	AbstractFeatureInterpretation	0..1

7.1.4 ElementIdentity

Stereotypes: XSDcomplexType

Indicates the nature of the relationship between 2 or more representations, specifically if they are partially or totally identical. For possible types of relationships, see IdentityKind.

Commonly used to identify contacts between representations in model descriptions. May also be used to relate the components of a grid (e.g., pillars) to those of a structural framework.

7.1.4.1 Attributes

Name	Data Type	Notes
IndexableElement	IndexableElements	
IdentityKind	IdentityKind	
ElementIndices	AbstractIntegerArray	Indicates which elements are identical based on their indices in the (sub)representation. If not given, then the selected indexable elements of each of the selected representations are identical at the element by element level. If not given, then all elements are specified to be identical. BUSINESS RULE: Number of identical elements must equal identicalElementCount for each representation.

Derived From: (none)

Derived Classes: (none)

7.1.4.2 Relationships

Role	Class	Cardinality
Representation	AbstractRepresentation	1..1
FromTimeIndex	TimeIndex	0..1
ToTimeIndex	TimeIndex	0..1

7.1.5 ElementIndices

Stereotypes: XSDcomplexType

Index into the indexable elements selected.

7.1.5.1 Attributes

Name	Data Type	Notes
IndexableElement	IndexableElements	
Indices	AbstractIntegerArray	

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.1.6 Patch

Stereotypes: XSDcomplexType

Set or range of one kind of topological element used to define part of a data-object; this concept exists for grid and structural data-objects.

Subset of a specified kind of indexable element of a representation, associated with a patch index. The patch index is used to define the relative order for the elements. It may also be used to access patches of indexable elements directly for geometry, properties, or relationships.

Patches are used to remove any ambiguity in data ordering among the indexable elements. For example, the triangle indexing of a triangulated set representation consists of multiple triangles, each with a patch index. This index specifies the relative ordering of the triangle patches. Those data-objects that inherit a patch index from the abstract class of patches all include the word “Patch” as part of their name, e.g., TrianglePatch.

7.1.6.1 Attributes

Name	Data Type	Notes
PatchIndex	nonNegativeInteger	Local index of the patch, making it unique within the representation.

Derived From: (none)

Derived Classes: Patch1d, GpGridIjkGridPatch, GpGridUnstructuredGridPatch, TruncationCellPatch, SubnodePatch, GpGridUnstructuredColumnLayerGridPatch, SplitNodePatch, PolylineSetPatch, Grid2dPatch

Relationships: None

7.1.7 Patch1d

Stereotypes: XSDcomplexType

A patch with a single 1D index count.

7.1.7.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of items in the patch.

Derived From: Patch

Derived Classes: SubRepresentationPatch, TrianglePatch, NodePatch, EdgePatch, ContactPatch

Relationships: None

7.1.8 PatchOfGeometry

Stereotypes: XSDcomplexType

Indicates which patch of the representation has a new geometry.

7.1.8.1 Attributes

Name	Data Type	Notes
RepresentationPatchIndex	nonNegativeInteger	Patch index for the geometry attachment, if required

Derived From: (none)

Derived Classes: (none)

7.1.8.2 Relationships

Role	Class	Cardinality
Geometry	AbstractGeometry	1..1

7.1.9 RedefinedGeometryRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A representation derived from an existing representation by redefining its geometry. Example use cases include deformation of the geometry of an object, change of coordinate system, and change of time <=> depth.

Derived From: AbstractRepresentation

Derived Classes: (none)

7.1.9.1 Relationships

Role	Class	Cardinality
PatchOfGeometry	PatchOfGeometry	1..*
SupportingRepresentation	AbstractRepresentation	1..1

7.1.10 RepresentationIdentity

Stereotypes: XSDcomplexType

Indicates the nature of the relationship between 2 or more representations, specifically if they are partially or totally identical. For possible types of relationships, see IdentityKind.

7.1.10.1 Attributes

Name	Data Type	Notes
IdenticalElementCount	positiveInteger	Number of elements within each representation for which a representation identity is specified.

Derived From: (none)

Derived Classes: (none)

7.1.10.2 Relationships

Role	Class	Cardinality
ElementIdentity	ElementIdentity	2..*
AdditionalGridTopology	AdditionalGridTopology	0..1

7.1.11 RepresentationIdentitySet

Stereotypes: XSDcomplexType,XSDtopLevelElement

A collection of representation identities.

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

7.1.11.1 Relationships

Role	Class	Cardinality
RepresentationIdentity	RepresentationIdentity	1..*

7.1.12 RepresentationSetRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The parent class of the framework representations. It is used to group together individual representations to represent a “bag” of representations. If the individual representations are all of the same, then you can indicate that the set is homogenous.

These “bags” do not imply any geologic consistency. For example, you can define a set of wellbore frames, a set of wellbore trajectories, a set of blocked wellbores.

Because the framework representations inherit from this class, they inherit the capability to gather individual representations into sealed and non-sealed surface framework representations, or sealed volume framework representations.

For more information, see the *RESQML Technical Usage Guide*.

7.1.12.1 Attributes

Name	Data Type	Notes
IsHomogeneous	boolean	Indicates that all of the selected representations are of a single kind.

Derived From: AbstractRepresentation

Derived Classes: SealedVolumeFrameworkRepresentation, AbstractSurfaceFrameworkRepresentation

7.1.12.2 Relationships

Role	Class	Cardinality
Representation	AbstractRepresentation	1..*

7.1.13 SubRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

An ordered list of indexable elements and/or indexable element pairs of an existing representation.

Because the representation concepts of topology, geometry, and property values are separate in RESQML, it is now possible to select a range of nodes, edges, faces, or volumes (cell) indices from the topological support of an existing representation to define a sub-representation.

A sub-representation may describe a different feature interpretation using the same geometry or property as the "parent" representation. In this case, the only information exchanged is a set of potentially non-consecutive indices of the topological support of the representation.

Derived From: AbstractRepresentation

Derived Classes: (none)

7.1.13.1 Relationships

Role	Class	Cardinality
AdditionalGridTopology	AdditionalGridTopology	0..1
SupportingRepresentation	AbstractRepresentation	1..1
SubRepresentationPatch	SubRepresentationPatch	1..*

7.1.14 SubRepresentationPatch

Stereotypes: XSDcomplexType

Each sub-representation patch has its own list of representation indices, drawn from the supporting representation.

If a list of pairwise elements is required, use two representation indices. The count of elements is defined in SubRepresenationPatch.

Optional additional grid topology is available for grid representations.

Derived From: Patch1d

Derived Classes: (none)

7.1.14.1 Relationships

Role	Class	Cardinality
ElementIndices	ElementIndices	1..2

7.2 Seismic Representations

A RESQML seismic survey representation makes use of previously defined representations, with the addition of seismic coordinates to their geometry.

A seismic survey is an organization of seismic lines. For the context of RESQML, a seismic survey does not refer to any vertical dimension information, but only areally at shot point locations or common midpoint gathers. The seismic traces, if needed by reservoir models, are transferred in an industry standard format such as SEGY. The SEGY format contains information about the number of samples in the seismic traces and whether the vertical domain is in time or depth. This section only discusses the areal aspects of seismic surveys.

RESQML supports two basic kinds of seismic surveys:

- seismic lattice (organization of the traces for the 3D acquisition and processing phases).
- seismic line (organization of the traces for the 2D acquisition and processing phases).

Additionally, to transport several seismic surveys together:

- Seismic lattices can be aggregated into a seismic lattice set.
- Seismic lines can be aggregated into a seismic line set.

Thus there are four groupings of seismic surveys, which are represented in RESQML as follows:

- A seismic lattice is generally represented using a 2D grid representation.
- A seismic lattice set is represented using a set of 2D grid representations.
- A seismic line is generally represented using a polyline representation.
- The seismic line set is then represented by a set of polyline representations.

In RESQML seismic surveys are technical features that do not have multiple interpretations. Although it is possible to re-interpret a seismic survey for improved physical properties or for positioning, these types of relationships are not included within the RESQML knowledge hierarchy.

7.2.1 AbstractSeismicCoordinates

Stereotypes: XSDcomplexType

Parent class is used to associate horizon and fault representations to seismic 2D and seismic 3D technical features. It stores a 1-to-1 mapping between geometry coordinates (usually X, Y, Z) and trace or inter-trace positions on a seismic survey.

Derived From: (none)

Derived Classes: Seismic2dCoordinates, Seismic3dCoordinates

7.2.1.1 Relationships

Role	Class	Cardinality
SeismicSupport	AbstractRepresentation	1..1

7.2.2 Seismic2dCoordinates

Stereotypes: XSDcomplexType

A group of 2D seismic coordinates that stores the 1-to-1 mapping between geometry patch coordinates (usually X, Y, Z) and trace or inter-trace positions on a seismic line.

BUSINESS RULE: This patch must reference a geometry patch by its UUID.

7.2.2.1 Attributes

Name	Data Type	Notes
LineAbscissa	AbstractDoubleArray	The sequence of trace or inter-trace positions that correspond to the geometry coordinates. BUSINESS RULE: Both sequences must be in the same order.
VerticalCoordinates	AbstractDoubleArray	The sequence of vertical sample or inter-sample positions that corresponds to the geometry coordinates. BUSINESS RULE: Sequence must be in the same order as the previous one.

Derived From: AbstractSeismicCoordinates

Derived Classes: (none)

Relationships: None

7.2.3 Seismic3dCoordinates

Stereotypes: XSDcomplexType

The 1-to-1 mapping between geometry coordinates (usually X, Y, Z or X, Y, TWT) and trace or inter-trace positions on a seismic lattice.

7.2.3.1 Attributes

Name	Data Type	Notes
CrosslineCoordinates	AbstractDoubleArray	The sequence of trace or inter-trace crossline positions that correspond to the geometry coordinates. BUSINESS RULE: Both sequences must be in the same order.
InlineCoordinates	AbstractDoubleArray	The sequence of trace or inter-trace inline positions that correspond to the geometry coordinates. BUSINESS RULE: Both sequences must be in the same order.
VerticalCoordinates	AbstractDoubleArray	The sequence of vertical sample or inter-sample positions that corresponds to the geometry coordinates. BUSINESS RULE: Sequence must be in the same order as the two previous ones.

Derived From: AbstractSeismicCoordinates

Derived Classes: (none)

Relationships: None

7.3 Grids

A grid is a RESQML representation that provides a cellular discretization of space. A grid shares three important characteristics with all other RESQML representations:

- A description of the topology (indexing) and geometry of the grid representation.
- A grid, or a subrepresentation of a grid, may provide a representation of an interpretation of a RESQML geologic feature, most often an earth model or a structural organization.
- Properties may be attached to a grid representation, i.e., a grid supplies the topological support for properties.

RESQML also provides a closely related “grid connection set” representation, which is based on “cell-face-pairs”, for the purpose of describing the connections between grid cells, and a “blocked wellbore” representation to describe wellbore trajectories discretized on a grid.

Although it may seem reasonable to organize grids by the geometry of their cells, industry applications more naturally segregate grids by their topology, i.e., the dimensionality of the indexing of the cells. RESQML follows this approach and supports six distinct grid classes:

- Three grid classes are fundamental and will be recognizable to most practitioners.

- Three grid classes are combinations of these fundamental classes, and provide support for advanced variations in unstructured grids.

All grids support various extensions, such as higher order cell geometry, although some extensions may only exist for particular classes. For example, only IJK grids support radial grid cell interpolation. The corner point grid supported by many applications is a specific example of an IJK grid, although without all of the extensions now supported in RESQML

For more information, see the Grid chapter in the *RESQML Technical Usage Guide*.

7.3.1 IjkIndexableElements

Indexable elements for IJK grids and patches.

Name	Data Type	Notes
cells	External Reference	Count = NI x NJ x NK
column edges	External Reference	Count = NIL*NJ + NI*NJL + #SplitColumnEdges
columns	External Reference	Count = NI x NJ = #Columns = columnCount
coordinate lines	External Reference	Count = #CoordinateLines = #Pillars + #SplitCoordinateLines
edges	External Reference	Count = #Edges = edgeCount
edges per column	External Reference	Ordered list of edges, specified (local) to a column = 0...3
faces	External Reference	Count = #Faces = #KFaces + #ColumnEdges x NK + #SplitFaces
faces per cell	External Reference	Ordered list of faces, specified (local) to a cell = 0...5
hinge node faces	External Reference	Count = NI x NJ x NKL (K faces)
interval edges	External Reference	Count = NKL = NK + gapCount + 1
intervals	External Reference	Count = NK + gapCount
I0	External Reference	Count = NI
I0 edges	External Reference	Count = NIL = NI+1
J0	External Reference	Count = NJ
J0 edges	External Reference	Count = NJL = NJ or NJ+1
layers	External Reference	Count = NK
nodes	External Reference	Count = #Nodes = #CoordinateLines x NKL
nodes per cell	External Reference	Ordered list of nodes, specified (local) to a cell = 0...7
nodes per edge	External Reference	Ordered list of nodes, specified (local) to an edge, 2 x edgeCount
nodes per face	External Reference	Ordered list of nodes, specified (local) to a face = 0...3

Name	Data Type	Notes
pillars	External Reference	Count = #Pillars = NIL x NJL + #SplitPillars
radial origin polyline	External Reference	Count = NKL
subnodes	External Reference	Count specified per subnode patch

7.3.2 KDirection

Enumeration used to specify if the direction of the coordinate lines is uniquely defined for a grid. If not uniquely defined, e.g., for over-turned reservoirs, then indicate that the K direction is not monotonic.

Name	Data Type	Notes
down	External Reference	K is increasing with depth, dot(tangent,gradDepth)>0.
up	External Reference	K is increasing with elevation, dot(tangent,gradDepth)<0.
not monotonic	External Reference	K is not monotonic with elevation, e.g., for over-turned structures.

7.3.3 PillarShape

Used to indicate that all pillars are of a uniform kind, i.e., may be represented using the same number of nodes per pillar. This information is supplied by the RESQML writer to indicate the complexity of the grid geometry, as an aide to the RESQML reader.

If a combination of vertical and straight, then use straight.

If a specific pillar shape is not appropriate, then use curved.

BUSINESS RULE: Should be consistent with the actual geometry of the grid.

Name	Data Type	Notes
vertical	External Reference	If represented by a parametric line, requires only a single control point per line.
straight	External Reference	If represented by a parametric line, requires 2 control points per line.
curved	External Reference	If represented by a parametric line, requires 3 or more control points per line.

7.3.4 GridGeometryAttachment

Indexable grid elements to which point geometry may be attached to describe additional grid geometry.

Name	Data Type	Notes
cells	External Reference	Geometry may be attached to cells to distort the geometry of that specific cell, only (finite element grid).
edges	External Reference	Geometry may be attached to edges to distort the geometry of all cells that refer to that edge (finite element grid). BUSINESS RULE: The edges indexing must be known

Name	Data Type	Notes
		or defined in the grid representation if geometry is attached to the edges.
faces	External Reference	Geometry may be attached to faces to distort the geometry of all cells that refer to that face (finite element grid). BUSINESS RULE: The faces indexing must be known or defined in the grid representation if geometry is attached to the faces.
hinge node faces	External Reference	For column layer grids, these are the K faces. For unstructured grids these faces are enumerated as the hinge node faces.
nodes	External Reference	Additional grid geometry may be attached to split or truncated node patches for column layer grids. All other node geometry attachment should be done through the Points array of the AbstractGridGeometry, not through the additional grid geometry.
radial origin polyline	External Reference	NKL points must be attached to the radial origin polyline for a grid with radial interpolation. BUSINESS RULE: The optional radialGridIsComplete element must be defined in the grid representation if geometry is attached to the radial origin polyline.
subnodes	External Reference	Geometry may be attached to subnodes to distort the geometry of all cells that refer to that subnode (finite element grid). BUSINESS RULE: An optional subnode patch object must be defined in the grid representation if geometry is attached to the subnodes.

7.3.5 CellShape

Used to indicate that all cells are of a uniform topology, i.e., have the same number of nodes per cell. This information is supplied by the RESQML writer to indicate the complexity of the grid geometry, as an aide to the RESQML reader.

If a specific cell shape is not appropriate, then use polyhedral.

BUSINESS RULE: Should be consistent with the actual geometry of the grid.

Name	Data Type	Notes
tetrahedral	External Reference	All grid cells are constrained to have only 4 nodes/cell with 4 faces/cell, 3 nodes/face, 4 nodes/cell for all cells (degeneracy allowed).
pyramidal	External Reference	All grid cells are constrained to have only 5 nodes/cell with 5 faces/cell, with 1 quadrilateral face and 4 triangular faces.
prism	External Reference	All grid cells are constrained to have 6 nodes/cell with 5 faces/cell, with 3 quadrilateral faces and 2 non-adjacent triangular faces, as in a column layer grid with triangular columns.

Name	Data Type	Notes
hexahedral	External Reference	All grid cells are constrained to have 8 nodes/cell with 6 faces/cell, 4 nodes/face, 8 nodes/cell for all cells (degeneracy allowed). Equivalent to IJK grid cells.
polyhedral	External Reference	If the cell geometry is not of a more specific kind, use polyhedral.

7.3.6 ColumnShape

Used to indicate that all columns are of a uniform topology, i.e., have the same number of faces per column. This information is supplied by the RESQML writer to indicate the complexity of the grid geometry, as an aide to the RESQML reader.

If a specific column shape is not appropriate, then use polygonal.

BUSINESS RULE: Should be consistent with the actual geometry of the grid.

Name	Data Type	Notes
triangular	External Reference	All grid columns have 3 sides.
quadrilateral	External Reference	All grid columns have 4 sides. Includes tartan and corner point grids.
polygonal	External Reference	At least one grid column is a polygon, N>4.

7.3.7 SubnodeNodeObject

SubnodeNodeObject is used to specify the node object that supports the subnodes. This determines the number of nodes per subnode and the continuity of the associated geometry or property. For instance, for hexahedral cells, cell indicates a fixed value of 8, while for an unstructured column layer grid, cell indicates that this count varies from column to column.

Name	Data Type	Notes
cell	External Reference	If geometry or properties are discontinuous from cell to cell (i.e., their spatial support is cell), then attach them to cell subnodes. BUSINESS RULE: If this object kind is selected, then an ordered list of nodes per cell must be specified or otherwise known.
face	External Reference	If geometry or properties are continuous between cells that share the same face (i.e., their spatial support is the face), then attach them to face subnodes. BUSINESS RULE: If this object kind is selected, then an ordered list of nodes per face must be specified or otherwise known.
edge	External Reference	If geometry and properties are continuous between cells that share the same edge of a face (i.e. their spatial support is the edge), then attach them to edge subnodes. BUSINESS RULE: If this object kind is selected, then an ordered list of nodes per edge must be specified or otherwise known.

7.3.8 UnstructuredCellIndexableElements

Indexable elements for unstructured cell grids and patches.

Name	Data Type	Notes
cells	External Reference	Count = #Cells = cellCount
edges	External Reference	Count = #Edges = edgeCount
faces	External Reference	Count = #Faces = faceCount
faces per cell	External Reference	Ordered list of faces, specified (local) to a cell
hinge node faces	External Reference	Count = #HingeNodeFaces
nodes	External Reference	Count = #Nodes = nodeCount
nodes per cell	External Reference	Ordered list of nodes, specified (local) to a cell
nodes per edge	External Reference	Ordered list of nodes, specified (local) to an edge, 2 x edgeCount
nodes per face	External Reference	Ordered list of nodes, specified (local) to a face
subnodes	External Reference	Count specified per subnode patch

7.3.9 UnstructuredColumnLayerIndexableElements

Indexable elements for unstructured column layer grids and patches.

Name	Data Type	Notes
cells	External Reference	Count = #Columns x NK
column edges	External Reference	Count = #UnstructuredColumnEdges + #SplitColumnEdges
columns	External Reference	Count = #Columns = columnCount
coordinate lines	External Reference	Count = #Pillars + #SplitCoordinateLines
edges	External Reference	Count = #Edges = edgeCount
edges per column	External Reference	Ordered list of edges, specified (local) to a column
faces	External Reference	Count = #KFaces + #ColumnEdges x NK
faces per cell	External Reference	Ordered list of faces, specified (local) to a cell
hinge node faces	External Reference	Count = #Columns x NKL (K faces)
interval edges	External Reference	Count = NKL = NK + gapCount + 1
intervals	External Reference	Count = NK + gapCount Only needed if the Unstructured Column Layer indices are a component of GPGrid.
layers	External Reference	Count = NK

Name	Data Type	Notes
nodes	External Reference	Count = #CoordinateLines x NKL
nodes per cell	External Reference	Ordered list of nodes, specified (local) to a cell
nodes per edge	External Reference	Ordered list of nodes, specified (local) to an edge, 2 x edgeCount
nodes per face	External Reference	Ordered list of nodes, specified (local) to a face
pillars	External Reference	Count = #Pillars = pillarCount
subnodes	External Reference	Count specified per subnode patch

7.3.10 AbstractColumnLayerGridGeometry

Stereotypes: XSDcomplexType

Description of the geometry of a column layer grid, e.g., parity and pinch, together with its supporting topology.

- Column layer grid cell geometry is based upon nodes on coordinate lines.
- Geometry is contained within the representation of a grid.
- Point Geometry is that of the column layer coordinate line nodes. Coordinate line nodes for all of the coordinate lines, with NKL nodes per line.
- The numbering of these lines follow the pillar numbering if no split coordinate lines are present.
- The unsplit coordinate lines share an indexing with the pillars. The numbering of the remaining lines are defined in the columnsPerSplitCoordinateLine list-of-lists if split coordinate lines are present.
- Pillar numbering is either 1D or 2D, so for unfaulted grids, the node dimensions may follow either a 2D or 3D array. Otherwise the nodes will be 2D.
- In HDF5 nodes are stored as separate X, Y, Z, values, so add another dimension (size=3) which is fastest in HDF5.

7.3.10.1 Attributes

Name	Data Type	Notes
CellGeometryIsDefined	AbstractBooleanArray	Indicator that a cell has a defined geometry. This attribute is grid metadata. If the indicator shows that the cell geometry is NOT defined, then this attribute overrides any other node geometry specification. Array index is 2D/3D.
KDirection	KDirection	
NodeIsColocatedInKDirection	AbstractBooleanArray	Optional indicator that two adjacent nodes on a coordinate line are colocated. This is considered grid metadata, and is intended to over-ride any geometric comparison of node locations. Array index follows #CoordinateLines x (NKL-1).
NodeIsColocatedOnKEdge	AbstractBooleanArray	Optional indicator that two adjacent nodes on the KEDGE of a cell are colocated. This is considered grid metadata, and is intended to over-ride any geometric comparison of node locations.

Name	Data Type	Notes
		Array index follows #EdgesPerColumn x NKL for unstructured column layer grids and 4 x NI x NJ x NKL for IJK grids.
PillarGeometryIsDefined	AbstractBooleanArray	Indicator that a pillar has at least one node with a defined cell geometry. This is considered grid metadata. If the indicator does not indicate that the pillar geometry is defined, then this over-rides any other node geometry specification. Array index follows #Pillars and so may be either 2D or 1D.
PillarShape	PillarShape	

Derived From: AbstractGridGeometry

Derived Classes: IjkGridGeometry, UnstructuredColumnLayerGridGeometry

7.3.10.2 Relationships

Role	Class	Cardinality
SubnodeTopology	ColumnLayerSubnodeTopology	0..1
SplitCoordinateLines	ColumnLayerSplitCoordinateLines	0..1
SplitNodes	SplitNodePatch	0..1

7.3.11 AbstractColumnLayerGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Abstract class that includes IJK grids and unstructured column layer grids. All column layer grids have a layer index K=1,...,NK or K0=0,...,NK-1.

Cell geometry is characterized by nodes on coordinate lines.

7.3.11.1 Attributes

Name	Data Type	Notes
Nk	positiveInteger	Number of layers in the grid. Must be positive.

Derived From: AbstractGridRepresentation

Derived Classes: IjkGridRepresentation, UnstructuredColumnLayerGridRepresentation

7.3.11.2 Relationships

Role	Class	Cardinality
IntervalStratigraphicUnits	IntervalStratigraphicUnits	0..1

7.3.12 AbstractGridGeometry

Stereotypes: XSDcomplexType

Grid geometry described by means of points attached to nodes and additional optional points which may be attached to other indexable elements of the grid representation.

Derived From: PointGeometry

Derived Classes: AbstractColumnLayerGridGeometry, UnstructuredGridGeometry

7.3.12.1 Relationships

Role	Class	Cardinality
AdditionalGridPoints	AdditionalGridPoints	0..*

7.3.13 AbstractGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Abstract class for all grid representations.

Derived From: AbstractRepresentation

Derived Classes: AbstractColumnLayerGridRepresentation, AbstractTruncatedColumnLayerGridRepresentation, GpGridRepresentation, UnstructuredGridRepresentation

7.3.13.1 Relationships

Role	Class	Cardinality
CellFluidPhaseUnits	CellFluidPhaseUnits	0..1
ParentWindow	AbstractParentWindow	0..1
CellStratigraphicUnits	CellStratigraphicUnits	0..1

7.3.14 AbstractParentWindow

Stereotypes: XSDcomplexType

Parent window specification, organized according to the topology of the parent grid. In addition to a window specification, for grids with I, J, and/or K coordinates, the parentage construction includes a regridding description that covers grid refinement, coarsening, or any combination of the two.

Derived From: (none)

Derived Classes: CellParentWindow, ColumnLayerParentWindow, IjkParentWindow

7.3.14.1 Relationships

Role	Class	Cardinality
CellOverlap	CellOverlap	0..1

7.3.15 AbstractTruncatedColumnLayerGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Abstract class for truncated IJK grids and truncated unstructured column layer grids. Each column layer grid class must have a defined geometry in which cells are truncated and additional split cells are defined.

7.3.15.1 Attributes

Name	Data Type	Notes

Name	Data Type	Notes
Nk	positiveInteger	Number of layers in the grid. Must be positive.

Derived From: AbstractGridRepresentation

Derived Classes: TruncatedIjkGridRepresentation, TruncatedUnstructuredColumnLayerGridRepresentation

7.3.15.2 Relationships

Role	Class	Cardinality
TruncationCells	TruncationCellPatch	1..1

7.3.16 Activation

Stereotypes: XSDcomplexType

Used to activate and deactivate the referencing object at the times indicated.

- If the activation object is not present, then the referencing object is always active.
- If the activation object is present, then the referencing object is not active until activated.

7.3.16.1 Attributes

Name	Data Type	Notes
ActivationToggleIndices	AbstractIntegerArray	The index in the time series at which the state of the referencing object is changed. Toggle changes state from inactive to active, or toggle changes state from active to inactive.

Derived From: (none)

Derived Classes: (none)

7.3.16.2 Relationships

Role	Class	Cardinality
TimeSeries	TimeSeries	1..1

7.3.17 AdditionalGridPoints

Stereotypes: XSDcomplexType

Geometry given by means of points attached to additional elements of a grid.

7.3.17.1 Attributes

Name	Data Type	Notes
RepresentationPatchIndex	nonNegativeInteger	Used to remove ambiguity in geometry attachment, if the attachment element is not sufficient. Usually required for subnodes and for the general purpose grid, but not otherwise.

Name	Data Type	Notes
Attachment	GridGeometryAttachment	
Points	AbstractPoint3dArray	

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.18 AdditionalGridTopology

Stereotypes: XSDcomplexType

Additional grid topology and/or patches, if required, for indexable elements that otherwise do not have their topology defined within the grid representation. For example, column edges need to be defined if you want to have an enumeration for the faces of a column layer grid, but not otherwise.

Derived From: (none)

Derived Classes: (none)

7.3.18.1 Relationships

Role	Class	Cardinality
SplitEdges	SplitEdges	0..1
SplitNodes	SplitNodePatch	0..1
SplitColumnEdges	ColumnLayerSplitColumnEdges	0..1
UnstructuredColumnEdges	UnstructuredColumnEdges	0..1
SplitFaces	SplitFaces	0..1
IjSplitColumnEdges	IjSplitColumnEdges	0..1
UnstructuredSubnodeTopology	UnstructuredSubnodeTopology	0..1
ColumnLayerSubnodeTopology	ColumnLayerSubnodeTopology	0..1

7.3.19 CellFluidPhaseUnits

Stereotypes: XSDcomplexType

A mapping from cells to fluid phase unit interpretation to describe the initial hydrostatic fluid column.

7.3.19.1 Attributes

Name	Data Type	Notes
PhaseUnitIndices	AbstractIntegerArray	Index of the phase unit kind within a given fluid phase organization for each cell. Follows the indexing defined by the PhaseUnit enumeration. When applied to the wellbore frame representation, the indexing is identical to the number of intervals.

Name	Data Type	Notes
		Use null (-1) if no fluid phase is present, e.g., within the seal. BUSINESS RULE: Array length is equal to the number of cells in the representation (grid, wellbore frame or blocked well).

Derived From: (none)

Derived Classes: (none)

7.3.19.2 Relationships

Role	Class	Cardinality
FluidOrganization	RockFluidOrganizationInterpretation	1..1

7.3.20 CellOverlap

Stereotypes: XSDcomplexType

Optional cell volume overlap information between the current grid (the child) and the parent grid. Use this data-object when the child grid has an explicitly defined geometry, and these relationships cannot be inferred from the regrid descriptions.

7.3.20.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of parent-child cell overlaps. Must be positive.
ParentChildCellPairs	AbstractIntegerArray	(Parent cell index, child cell index) pair for each overlap. BUSINESS RULE: Length of array must equal 2 x overlapCount.

Derived From: (none)

Derived Classes: (none)

7.3.20.2 Relationships

Role	Class	Cardinality
OverlapVolume	OverlapVolume	0..1

7.3.21 CellParentWindow

Stereotypes: XSDcomplexType

Parent window for ANY grid indexed as if it were an unstructured cell grid, i.e., using a 1D index.

7.3.21.1 Attributes

Name	Data Type	Notes
CellIndices	AbstractIntegerArray	Cell indices that list the cells in the parent window. BUSINESS RULE: Number of cells must be consistent with the child grid cell count.

Derived From: AbstractParentWindow

Derived Classes: (none)

7.3.21.2 Relationships

Role	Class	Cardinality
ParentGrid	AbstractGridRepresentation	1..1

7.3.22 CellStratigraphicUnits

Stereotypes: XSDcomplexType

A mapping from cell to stratigraphic unit interpretation for representations (grids or blocked wells).

7.3.22.1 Attributes

Name	Data Type	Notes
UnitIndices	AbstractIntegerArray	Index of the stratigraphic unit of a given stratigraphic column for each cell. Use null (-1) if no stratigraphic column, e.g., within salt BUSINESS RULE: Array length is the number of cells in the grid or the blocked well.

Derived From: (none)

Derived Classes: (none)

7.3.22.2 Relationships

Role	Class	Cardinality
StratigraphicOrganization	AbstractStratigraphicOrganizationInterpretation	1..1

7.3.23 ColumnLayerParentWindow

Stereotypes: XSDcomplexType

Parent window for any column-layer grid indexed as if it were an unstructured column layer grid, i.e., IJ columns are replaced by a column index.

7.3.23.1 Attributes

Name	Data Type	Notes
ColumnIndices	AbstractIntegerArray	Column indices that list the columns in the parent window. BUSINESS RULE: Number of columns must be consistent with the child grid column count.
OmitParentCells	AbstractIntegerArray	List of parent cells that are to be retained at their original resolution and are not to be included within a local grid. The "omit" allows non-rectangular local grids to be specified. 0-based indexing follows #Columns x #Layers relative to the parent window cell count, not to the parent grid.

Derived From: AbstractParentWindow

Derived Classes: (none)

7.3.23.2 Relationships

Role	Class	Cardinality
KRegrid	Regrid	1..1
ParentGrid	AbstractColumnLayerGridRepresentation	1..1

7.3.24 ColumnLayerSplitColumnEdges

Stereotypes: XSDcomplexType

Column edges are needed to construct the indices for the cell faces for column-layer grids. For split column-layer grids, the column edge indices must be defined explicitly. Column edges are not required to describe the lowest order grid geometry, but may be required for higher order geometries or properties.

7.3.24.1 Attributes

Name	Data Type	Notes
ColumnPerSplitColumnEdge	AbstractIntegerArray	Column index for each of the split column edges. Used to implicitly define column and cell faces. List-of-lists construction not required because each split column edge must be in a single column.
Count	positiveInteger	Number of split column edges in this grid. Must be positive.
ParentColumnEdgeIndices	AbstractIntegerArray	Parent unsplit column edge index for each of the split column edges. Used to implicitly define split face indexing.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.25 ColumnLayerSplitCoordinateLines

Stereotypes: XSDcomplexType

Definition of the indexing for the split coordinate lines. When present, this indexing contributes to the coordinate line nodes.

7.3.25.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of split coordinate lines. The count must be positive.
PillarIndices	AbstractIntegerArray	Pillar index for each split coordinate line. Length of this array is equal to the number of split coordinate lines. For the first pillarCount lines, the index of the coordinate line equals the index of the corresponding pillar. This array provides the pillar indices for the additional (split) coordinate lines. Used to implicitly define column and cell geometry.
ColumnsPerSplitCoordinateLine	ResqmlJaggedArray	Column indices for each of the split coordinate lines. Used to implicitly define column and cell geometry. List-of-lists construction used to support shared coordinate lines.

Derived From: (none)

Derived Classes: (none)

7.3.25.2 Relationships

Role	Class	Cardinality
SplitColumnEdges	ColumnLayerSplitColumnEdges	0..1

7.3.26 ColumnLayerSubnodeTopology

Stereotypes: XSDcomplexType

This data-object consists of the unstructured cell finite elements subnode topology plus the column subnodes.

Derived From: SubnodeTopology

Derived Classes: (none)

7.3.26.1 Relationships

Role	Class	Cardinality
ColumnSubnodes	ColumnSubnodePatch	0..*

7.3.27 ColumnSubnodePatch

Stereotypes: XSDcomplexType

Use this subnode construction if the number of subnodes per object varies from column to column, but does not vary from layer to layer.

7.3.27.1 Attributes

Name	Data Type	Notes
SubnodeCountPerObject	AbstractIntegerArray	Number of subnodes per object, with a different number in each column of the grid.

Derived From: SubnodePatch

Derived Classes: (none)

Relationships: None

7.3.28 ConnectionInterpretations

Stereotypes: XSDcomplexType

For each connection in the grid connection set representation, zero, one or more feature-interpretations. The use of a jagged array allows multiple interpretations for each connection, e.g., to represent multiple faults discretized onto a single connection. Note: Feature-interpretations are not restricted to faults, so that a connection may also represent a horizon or geobody boundary, for example.

7.3.28.1 Attributes

Name	Data Type	Notes
InterpretationIndices	ResqmlJaggedArray	Indices for the interpretations for each connection, if any. The use of a RESQML jagged array allows zero or more than one interpretation to be associated with a single connection.

Derived From: (none)

Derived Classes: (none)

7.3.28.2 Relationships

Role	Class	Cardinality
FeatureInterpretation	AbstractFeatureInterpretation	1..*

7.3.29 Edges

Stereotypes: XSDcomplexType

Unstructured cell grids require the definition of edges if the subnode attachment is of kind edges.

Use Case: Finite elements, especially for higher order geometry.

BUSINESS RULE: Edges must be defined for unstructured cell grids if subnode nodes of kind edges are used.

7.3.29.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of edges. Must be positive.
NodesPerEdge	AbstractIntegerArray	Defines a list of 2 nodes per edge. Count = 2 x EdgeCount

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.30 GpGridColumnLayerGrid

Stereotypes: XSDcomplexType

Used to construct a column layer grid patch based upon multiple unstructured column-layer and IJK grids that share a layering scheme.

Multiple patches are supported.

7.3.30.1 Attributes

Name	Data Type	Notes
Nk	nonNegativeInteger	Number of layers. Degenerate case (nk=0) is allowed for GPGrid.

Derived From: (none)

Derived Classes: (none)

7.3.30.2 Relationships

Role	Class	Cardinality
KGaps	KGaps	0..1
IjkGridPatch	GpGridIjkGridPatch	0..*
UnstructuredColumnLayerGridPatch	GpGridUnstructuredColumnLayerGridPatch	0..*

7.3.31 GpGridIjkGridPatch

Stereotypes: XSDcomplexType

Used to specify IJK grid patch(es) within a general purpose grid.

Multiple patches are supported.

7.3.31.1 Attributes

Name	Data Type	Notes
Ni	nonNegativeInteger	Count of I indices. Degenerate case (ni=0) is allowed for GPGrid representations.
Nj	nonNegativeInteger	Count of J indices. Degenerate case (nj=0) is allowed for GPGrid representations.
RadialGridIsComplete	boolean	TRUE if the grid is periodic in J, i.e., has the topology of a complete 360 degree circle. If TRUE, then NJL=NJ. Otherwise, NJL=NJ+1

Derived From: Patch

Derived Classes: (none)

7.3.31.2 Relationships

Role	Class	Cardinality
Geometry	IjkGridGeometry	0..1
TruncationCells	TruncationCellPatch	0..1

7.3.32 GpGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

General purpose (GP) grid representation, which includes and/or extends the features from all other grid representations. This general purpose representation is included in the schema for research and/or advanced modeling purposes, but is not expected to be used for routine data transfer.

Derived From: AbstractGridRepresentation

Derived Classes: (none)

7.3.32.1 Relationships

Role	Class	Cardinality
ColumnLayerGrid	GpGridColumnLayerGrid	0..*
UnstructuredGridPatch	GpGridUnstructuredGridPatch	0..*

7.3.33 GpGridUnstructuredColumnLayerGridPatch

Stereotypes: XSDcomplexType

Used to specify unstructured column-layer grid patch(es) within a general purpose grid.

Multiple patches are supported.

7.3.33.1 Attributes

Name	Data Type	Notes
UnstructuredColumnCount	nonNegativeInteger	Number of unstructured columns. Degenerate case (count=0) is allowed for GPGrid.

Derived From: Patch

Derived Classes: (none)

7.3.33.2 Relationships

Role	Class	Cardinality
Geometry	UnstructuredColumnLayerGridGeometry	0..1
TruncationCells	TruncationCellPatch	0..1

7.3.34 GpGridUnstructuredGridPatch

Stereotypes: XSDcomplexType

Used to specify unstructured cell grid patch(es) within a general purpose grid.

Multiple patches are supported.

7.3.34.1 Attributes

Name	Data Type	Notes
UnstructuredCellCount	nonNegativeInteger	Number of unstructured cells. Degenerate case (count=0) is allowed for GPGrid.

Derived From: Patch

Derived Classes: (none)

7.3.34.2 Relationships

Role	Class	Cardinality
Geometry	UnstructuredGridGeometry	0..1

7.3.35 GridConnectionSetRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Representation that consists of a list of connections between grid cells, potentially on different grids.

Connections are in the form of (Grid,Cell,Face)1<=>(Grid,Cell,Face)2 and are stored as three integer pair arrays corresponding to these six elements.

Grid connection sets are the preferred means of representing faults on a grid. The use of cell-face-pairs is more complete than single cell-faces, which are missing a corresponding cell face entry, and only provide an incomplete representation of the topology of a fault.

Unlike what is sometimes the case in reservoir simulation software, RESQML does not distinguish between standard and non-standard connections.

Within RESQML, if a grid connection corresponds to a "nearest neighbor" as defined by the cell indices, then it is never additive to the implicit nearest neighbor connection.

BUSINESS RULE: A single cell-face-pair should not appear within more than a single grid connection set. This rule is designed to simplify the interpretation of properties assigned to multiple grid connection sets, which might otherwise have the same property defined more than once on a single connection, with no clear means of resolving the multiple values.

7.3.35.1 Attributes

Name	**Data Type**	**Notes**
CellIndexPairs	AbstractIntegerArray	2 x #Connections array of cell indices for (Cell1,Cell2) for each connection.
Count	positiveInteger	count of connections. Must be positive.
GridIndexPairs	AbstractIntegerArray	2 x #Connections array of grid indices for (Cell1,Cell2) for each connection. The grid indices are obtained from the grid index pairs. If only a single grid is referenced from the grid index, then this array need not be used. BUSINESS RULE: If more than one grid index pair is referenced, then this array should appear.
LocalFacePerCellIndexPairs	AbstractIntegerArray	Optional 2 x #Connections array of local face-per-cell indices for (Cell1,Cell2) for each connection. Local face-per-cell indices are used because global face indices need not have been defined. Null value = -1. If no face-per-cell definition occurs as part of the grid representation, e.g., for a block-centered grid, then this array need not appear.

Derived From: AbstractRepresentation

Derived Classes: (none)

7.3.35.2 Relationships

Role	**Class**	**Cardinality**
ConnectionInterpretations	ConnectionInterpretations	0..1
Grid	AbstractGridRepresentation	1..*

7.3.36 IjGaps

Stereotypes: XSDcomplexType

Optional object used to indicate that adjacent columns of the model are split from each other, which is modeled by introducing additional (split) pillars.

7.3.36.1 Attributes

Name	Data Type	Notes
SplitPillarCount	positiveInteger	Number of split pillars in the model. Count must be positive.
ParentPillarIndices	AbstractIntegerArray	Parent pillar index for each of the split pillars. This information is used to infer the grid cell geometry. BUSINESS RULE: Array length must match splitPillarCount.
ColumnsPerSplitPillar	ResqmlJaggedArray	List of columns for each of the split pillars. This information is used to infer the grid cell geometry. BUSINESS RULE: The length of the first list-of-lists array must match the splitPillarCount.

Derived From: (none)

Derived Classes: (none)

7.3.36.2 Relationships

Role	Class	Cardinality
IjSplitColumnEdges	IjSplitColumnEdges	0..1

7.3.37 IjkGridGeometry

Stereotypes: XSDcomplexType

Explicit geometry definition for the cells of the IJK grid.

Grid options are also defined through this data-object.

7.3.37.1 Attributes

Name	Data Type	Notes
GridIsRighthanded	boolean	Indicates that the IJK grid is right handed, as determined by the triple product of tangent vectors in the I, J, and K directions.

Derived From: AbstractColumnLayerGridGeometry

Derived Classes: (none)

7.3.37.2 Relationships

Role	Class	Cardinality
IjGaps	IjGaps	0..1

7.3.38 IjkGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Grid whose topology is characterized by structured column indices (I,J) and a layer index, K.

Cell geometry is characterized by nodes on coordinate lines, where each column of the model has 4 sides. Geometric degeneracy is permitted.

IJK grids support the following specific extensions:

- IJK radial grids
- K-Layer gaps
- IJ-Column gaps

7.3.38.1 Attributes

Name	Data Type	Notes
Ni	positiveInteger	Count of cells in the I-direction in the grid. Must be positive. I=1,...,NI, I0=0,...,NI-1.
Nj	positiveInteger	Count of cells in the J-direction in the grid. Must be positive. J=1,...,NJ, J0=0,...,NJ-1.
RadialGridIsComplete	boolean	TRUE if the grid is periodic in J, i.e., has the topology of a complete 360 degree circle. If TRUE, then NJL=NJ. Otherwise, NJL=NJ+1 May be used to change the grid topology for either a Cartesian or a radial grid, although radial grid usage is by far the more common.

Derived From: AbstractColumnLayerGridRepresentation

Derived Classes: (none)

7.3.38.2 Relationships

Role	Class	Cardinality
KGaps	KGaps	0..1
Geometry	IjkGridGeometry	0..1

7.3.39 IjkParentWindow

Stereotypes: XSDcomplexType

Parent window for any IJK grid.

7.3.39.1 Attributes

Name	Data Type	Notes
OmitParentCells	AbstractIntegerArray	List of parent cells that are to be retained at their original resolution and are not to be included within a local grid. The "omit" allows non-rectangular local grids

Name	Data Type	Notes
		to be specified. 0-based indexing follows NI x NJ x NK relative to the parent window cell count—not to the parent grid.

Derived From: AbstractParentWindow

Derived Classes: (none)

7.3.39.2 Relationships

Role	Class	Cardinality
JRegrid	Regrid	1..1
ParentGrid	IjkGridRepresentation	1..1
KRegrid	Regrid	1..1
IRegrid	Regrid	1..1

7.3.40 IjSplitColumnEdges

Stereotypes: XSDcomplexType

Used to construct the indices for the cell faces. For IJK grids with IJ gaps, the split column edge indices must be defined explicitly. Otherwise, column edges are not required to describe the lowest order grid geometry, but may be needed for higher order geometries or properties.

7.3.40.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of IJ split column edges in this grid. Must be positive.
PillarsPerSplitColumnEdge	ResqmlJaggedArray	Definition of the split column edges in terms of the pillars per split column edge. Pillar count per edge is usually 2, but the list-of-lists construction is used to allow split column edges to be defined by more than 2 pillars.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.41 Intervals

Stereotypes: XSDcomplexType

Refinement and/or coarsening per interval.

If there is a 1:1 correspondence between the parent and child cells, then this object is not needed.

7.3.41.1 Attributes

Name	Data Type	Notes
ChildCellWeights	AbstractDoubleArray	Weights that are proportional to the relative sizes of child cells within each interval. The weights need not be normalized.
ChildCountPerInterval	AbstractIntegerArray	The number of child cells in each interval. If the child grid type is not commensurate with the parent type, then this attribute is ignored by a reader and its value should be set to null (-1). For example, for a parent IJK grid with a child unstructured column-layer grid, then the child count is non-null for a K regrid, but null for an I or J regrid. BUSINESS RULES: 1.) The array length must be equal to intervalCount. 2.) If the child grid type is commensurate with the parent grid, then the sum of values over all intervals must be equal to the corresponding child grid dimension.
IntervalCount	positiveInteger	The number of intervals in the regrid description. Must be positive.
ParentCountPerInterval	AbstractIntegerArray	The number of parent cells in each interval. BUSINESS RULES: 1.) The array length must be equal to intervalCount. 2.) For the given parentIndex, the total count of parent cells should not extend beyond the boundary of the parent grid.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.42 IntervalStratigraphicUnits

Stereotypes: XSDcomplexType

A mapping from intervals to stratigraphic units for representations (grids or wellbore frames).

7.3.42.1 Attributes

Name	Data Type	Notes
UnitIndices	AbstractIntegerArray	Index of the stratigraphic unit per interval, of a given stratigraphic column. Notes: 1.) For grids, intervals = layers + K gaps. 2.) If there is no stratigraphic column, e.g., within salt, use null (-1) BUSINESS RULE: Array length must equal the number of intervals.

Derived From: (none)

Derived Classes: (none)

7.3.42.2 Relationships

Role	Class	Cardinality
StratigraphicOrganization	AbstractStratigraphicOrganizationInterpretation	1..1

7.3.43 KGaps

Stereotypes: XSDcomplexType

Optional data-object used to indicate that there are global gaps between layers in the grid. With K gaps, the bottom of one layer need not be continuous with the top of the next layer, so the resulting number of intervals is greater than the number of layers.

7.3.43.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of gaps between layers. Must be positive. Number of intervals = gapCount + NK.
GapAfterLayer	AbstractBooleanArray	Boolean array of length NK-1. TRUE if there is a gap after the corresponding layer. NKL = NK + gapCount + 1 BUSINESS RULE: gapCount must be consistent with the number of gaps specified by the gapAfterLayer array.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.44 LocalGridSet

Stereotypes: XSDcomplexType,XSDtopLevelElement

Used to activate and/or deactivate the specified children grids as local grids on their parents. Once activated, this object indicates that a child grid replaces local portions of the corresponding parent grid. Parentage is inferred from the child grid construction. Without a grid set activation, the local grids are always active. Otherwise, the grid set activation is used to activate and/or deactivate the local grids in the set at specific times.

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

7.3.44.1 Relationships

Role	Class	Cardinality
Activation	Activation	0..1
ChildGrid	AbstractGridRepresentation	1..*

7.3.45 NodesPerCell

Stereotypes: XSDcomplexType

Optional component of Unstructured Cell Finite Elements.

For effective use of the RESQML finite element representations, the choice of node order per cell is important . If you are working with an application with a particular node ordering per cell, be sure to specify the nodes in that order here, for ease of use.

BUSINESS RULE: If cell subnodes are used for unstructured grids, then nodes per cell must be defined.

7.3.45.1 Attributes

Name	Data Type	Notes
NodesPerCell	ResqmlJaggedArray	Defines an ordered list of nodes per cell.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.46 OverlapVolume

Stereotypes: XSDcomplexType

Optional parent-child cell overlap volume information. If not present, then the CellOverlap data-object lists the overlaps, but with no additional information.

7.3.46.1 Attributes

Name	Data Type	Notes
VolumeUom	VolumeUom	Units of measure for the overlapVolume.
OverlapVolumes	AbstractDoubleArray	Parent-child cell volume overlap. BUSINESS RULE: Length of array must equal the cell overlap count.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.47 Regrid

Stereotypes: XSDcomplexType

One-dimensional I, J, or K refinement and coarsening regrid specification.

The regrid description is organized using intervals. Within each interval, the number of parent and child cells is specified. Parent and child grid cell faces are aligned at interval boundaries. By default, child cells are uniformly sized within an interval unless weights are used to modify their size.

If the child grid is a root grid with an independent geometry, then there will usually be only a single interval for a regrid, because internal cell faces are not necessarily aligned.

7.3.47.1 Attributes

Name	Data Type	Notes
InitialIndexOnParentGrid	nonNegativeInteger	0-based index for the placement of the window on the parent grid.

Derived From: (none)

Derived Classes: (none)

7.3.47.2 Relationships

Role	Class	Cardinality
Intervals	Intervals	0..1

7.3.48 SplitEdges

Stereotypes: XSDcomplexType

If split nodes are used in the construction of a column-layer grid and indexable elements of kind edges are referenced, then the grid edges need to be re-defined.

Use Case: finite elements, especially for higher order geometry.

7.3.48.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of edges. Must be positive.
ParentEdgeIndices	AbstractIntegerArray	Parent unsplit edge index for each of the additional split edges.
FacesPerSplitEdge	ResqmlJaggedArray	Association of faces with the split edges, used to infer continuity of property, geometry, or interpretation with an attachment kind of edges.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.49 SplitFaces

Stereotypes: XSDcomplexType

Optional construction used to introduce additional faces created by split nodes. Used to represent complex geometries, e.g., for stair-step grids and reverse faults.

7.3.49.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of additional split faces. Count must be positive.
ParentFaceIndices	AbstractIntegerArray	Parent unsplit face index for each of the additional split faces.
CellIndices	AbstractIntegerArray	Cell index for each split face. Used to implicitly define cell geometry.

Derived From: (none)

Derived Classes: (none)

7.3.49.2 Relationships

Role	Class	Cardinality
SplitEdges	SplitEdges	0..1

7.3.50 SplitNodePatch

Stereotypes: XSDcomplexType

Optional construction used to introduce additional nodes on coordinate lines. Used to represent complex geometries, e.g., for stair-step grids and reverse faults.

BUSINESS RULE: Patch Index must be positive because a patch index of 0 refers to the fundamental column-layer coordinate line nodes.

7.3.50.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of additional split nodes. Count must be positive.
ParentNodeIndices	AbstractIntegerArray	Parent coordinate line node index for each of the split nodes. Used to implicitly define cell geometry.
CellsPerSplitNode	ResqmlJaggedArray	Cell indices for each of the split nodes. Used to implicitly define cell geometry. List-of-lists construction used to support split nodes shared between multiple cells.

Derived From: Patch

Derived Classes: (none)

7.3.50.2 Relationships

Role	Class	Cardinality
SplitFaces	SplitFaces	0..1

7.3.51 SubnodePatch

Stereotypes: XSDcomplexType

Each patch of subnodes is defined independently of the others. Number of nodes per object is determined by the subnode kind.

7.3.51.1 Attributes

Name	Data Type	Notes
SubnodeNodeObject	SubnodeNodeObject	
NodeWeightsPerSubnode	AbstractValueArray	Node weights for each subnode. Count of nodes per subnode is known for each specific subnode construction. Data order consists of all the nodes for each subnode in turn. For example, if uniform and stored as a multi-dimensional array, the node index cycles first. BUSINESS RULE: Weights must be non-negative. BUSINESS RULE: Length of array must be consistent with the sum of nodeCount x subnodeCount per object, e.g., for 3 subnodes per edge (uniform), there are 6 weights.

Derived From: Patch

Derived Classes: VariableSubnodePatch, UniformSubnodePatch, ColumnSubnodePatch

Relationships: None

7.3.52 SubnodeTopology

Stereotypes: XSDcomplexType

Finite element subnode topology for an unstructured cell can be either variable or uniform, but not columnar.

Derived From: (none)

Derived Classes: ColumnLayerSubnodeTopology, UnstructuredSubnodeTopology

7.3.52.1 Relationships

Role	Class	Cardinality
VariableSubnodes	VariableSubnodePatch	0..*
UniformSubnodes	UniformSubnodePatch	0..*

7.3.53 TruncatedIjkGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Grid class with an underlying IJK topology, together with a 1D split-cell list. The truncated IJK cells have more than the usual 6 faces. The split cells are arbitrary polyhedra, identical to those of an unstructured cell grid.

7.3.53.1 Attributes

Name	Data Type	Notes
Ni	positiveInteger	Count of I-indices in the grid. Must be positive.
Nj	positiveInteger	Count of J-indices in the grid. Must be positive.

Derived From: AbstractTruncatedColumnLayerGridRepresentation

Derived Classes: (none)

7.3.53.2 Relationships

Role	Class	Cardinality
Geometry	IjkGridGeometry	1..1

7.3.54 TruncatedUnstructuredColumnLayerGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Grid class with an underlying unstructured column-layer topology, together with a 1D split-cell list. The truncated cells have more than the usual number of faces within each column. The split cells are arbitrary polyhedra, identical to those of an unstructured cell grid.

7.3.54.1 Attributes

Name	Data Type	Notes
ColumnCount	positiveInteger	Number of unstructured columns in the grid. Must be positive.

Derived From: AbstractTruncatedColumnLayerGridRepresentation

Derived Classes: (none)

7.3.54.2 Relationships

Role	Class	Cardinality
Geometry	UnstructuredColumnLayerGridGeometry	1..1

7.3.55 TruncationCellPatch

Stereotypes: XSDcomplexType

Truncation definitions for the truncated and split cells.

BUSINESS RULE: Patch Index must be positive because a patch index of 0 refers to the fundamental column-layer coordinate line nodes and cells.

7.3.55.1 Attributes

Name	Data Type	Notes
LocalFacesPerCell	ResqmlJaggedArray	Local cell face index for those faces that are retained from the parent cell in the definition of the truncation cell. The use of a local cell-face index, e.g., 0...5 for an IJK cell, can be used even if the face indices have not been defined.
NodesPerTruncationFace	ResqmlJaggedArray	Definition of the truncation faces is in terms of an ordered list of nodes. Node indexing is EXTENDED, i.e., is based on the list of untruncated grid nodes (always first) plus the split nodes (if any) and the truncation face nodes. Relative order of split nodes and truncation face nodes is set by the pillar indices.
ParentCellIndices	AbstractIntegerArray	Parent cell index for each of the truncation cells. BUSINESS RULE: Size must match truncationCellCount
TruncationCellCount	positiveInteger	Number of polyhedral cells created by truncation. Must be positive. Note: Parent cells are replaced.
TruncationCellFaceIsRightHanded	AbstractBooleanArray	Boolean mask used to indicate which truncation cell faces have an outwardly directed normal, following a right hand rule. Data size and order follows the truncationFacesPerCell list-of-lists.
TruncationFaceCount	positiveInteger	Number of additional faces required for the split and truncation construction. The construction does not modify existing face definitions, but instead uses these new faces to redefine the truncated cell geometry. Must be positive. These faces are added to the enumeration of faces for the grid
TruncationFacesPerCell	ResqmlJaggedArray	Truncation face index for the additional cell faces that are required to complete the definition of the truncation cell. The resulting local cell face index follows the local faces-per-cell list, followed by the truncation faces in the order within the list-of-lists constructions.
TruncationNodeCount	positiveInteger	Number of additional nodes required for the truncation construction. Must be positive. Uses a separate enumeration and does not increase the number of nodes, except as noted below.

Derived From: Patch

Derived Classes: (none)

Relationships: None

7.3.56 UniformSubnodePatch

Stereotypes: XSDcomplexType

Use this subnode construction if the number of subnodes is the same for every object, e.g., 3 subnodes per edge for all edges.

7.3.56.1 Attributes

Name	Data Type	Notes
SubnodeCountPerObject	positiveInteger	Number of subnodes per object, with the same number for each of this data-object kind in the grid.

Derived From: SubnodePatch

Derived Classes: (none)

Relationships: None

7.3.57 UnstructuredColumnEdges

Stereotypes: XSDcomplexType

Column edges are used to construct the index for faces. For unstructured column-layer grids, the column edge indices must be defined explicitly. Column edges are not required to describe lowest order grid geometry, but may be needed for higher order geometries or properties.

7.3.57.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of unstructured column edges in this grid. Must be positive.
PillarsPerColumnEdge	ResqmlJaggedArray	Definition of the column edges in terms of the pillars-per-column edge. Pillar count per edge is usually 2, but the list-of-lists construction is used to allow column edges to be defined by more than 2 pillars.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.58 UnstructuredColumnLayerGridGeometry

Stereotypes: XSDcomplexType

Description of the geometry of an unstructured column-layer grid, e.g., parity and pinch, together with its supporting topology.

Unstructured column-layer cell geometry is derived from column-layer cell geometry and hence is based upon nodes on coordinate lines.

Geometry is contained within the representation of a grid.

7.3.58.1 Attributes

Name	Data Type	Notes
ColumnIsRightHanded	AbstractBooleanArray	List of columns that are right handed. Right handedness is evaluated following the pillar order and the K-direction tangent vector for each column.
ColumnShape	ColumnShape	
PillarCount	positiveInteger	Number of pillars in the grid. Must be positive. Pillars are used to describe the shape of the columns in the grid.
PillarsPerColumn	ResqmlJaggedArray	List of pillars for each column. The pillars define the corners of each column. The number of pillars per column can be obtained from the offsets in the first list-of-lists array. BUSINESS RULE: The length of the first array in the list -of-lists construction must equal the columnCount.

Derived From: AbstractColumnLayerGridGeometry

Derived Classes: (none)

7.3.58.2 Relationships

Role	Class	Cardinality
ColumnEdges	UnstructuredColumnEdges	0..1

7.3.59 UnstructuredColumnLayerGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Grid whose topology is characterized by an unstructured column index and a layer index, K.

Cell geometry is characterized by nodes on coordinate lines, where each column of the model may have an arbitrary number of sides.

7.3.59.1 Attributes

Name	Data Type	Notes
ColumnCount	positiveInteger	Number of unstructured columns in the grid. Must be positive.

Derived From: AbstractColumnLayerGridRepresentation

Derived Classes: (none)

7.3.59.2 Relationships

Role	Class	Cardinality
Geometry	UnstructuredColumnLayerGridGeometry	0..1

7.3.60 UnstructuredGridGeometry

Stereotypes: XSDcomplexType

Description of the geometry of an unstructured cell grid, which includes geometric characteristics, e.g., cell face parity, and supporting topology.

Each grid cell is defined by a (signed) list of cell faces. Each cell face is defined by a list of nodes.

Attributes

Name	Data Type	Notes
CellFaceIsRightHanded	AbstractBooleanArray	Boolean mask used to indicate which cell faces have an outwardly directed normal following a right hand rule. Array length is the sum of the cell face count per cell, and the data follows the order of the faces per cell RESQMLlist-of-lists.
CellShape	CellShape	
FaceCount	positiveInteger	Total number of faces in the grid. Must be positive.
FacesPerCell	ResqmlJaggedArray	List of faces per cell. face count per cell can be obtained from the offsets in the first list-of-listS array. BUSINESS RULE: cellCount must match the length of the first list-of-lists array.
NodeCount	positiveInteger	Total number of nodes in the grid. Must be positive.
NodesPerFace	ResqmlJaggedArray	List of nodes per face. Node count per face can be obtained from the offsets in the first list-of-lists array. BUSINESS RULE: faceCount must match the length of the first list- of-lists array.

Derived From: AbstractGridGeometry

Derived Classes: (none)

7.3.60.1 Relationships

Role	Class	Cardinality
HingeNodeFaces	UnstructuredGridHingeNodeFaces	0..1
SubnodeTopology	UnstructuredSubnodeTopology	0..1

7.3.61 UnstructuredGridHingeNodeFaces

Stereotypes: XSDcomplexType

Hinge nodes define a triangulated interpolation on a cell face. In practice, they arise on the K faces of column layer cells and are used to add additional geometric resolution to the shape of the cell. The specification of triangulated interpolation also uniquely defines the interpolation schema on the cell face, and hence the cell volume.

For an unstructured cell grid, the hinge node faces need to be defined explicitly.

This hinge node faces data-object is optional and is only expected to be used if the hinge node faces higher order grid point attachment arises. Hinge node faces are not supported for property attachment. Instead use a subrepresentation or an attachment kind of faces or faces per cell.

BUSINESS RULE: Each cell must have either 0 or 2 hinge node faces, so that the two hinge nodes for the cell may be used to define a cell center line and a cell thickness.

7.3.61.1 Attributes

Name	Data Type	Notes
Count	positiveInteger	Number of K faces. This count must be positive.
FaceIndices	AbstractIntegerArray	List of faces to be identified as K faces for hinge node geometry attachment. BUSINESS RULE: Array length equals K face count.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.3.62 UnstructuredGridRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Unstructured grid representation characterized by a cell count, and potentially nothing else. Both the oldest and newest simulation formats are based on this format.

7.3.62.1 Attributes

Name	Data Type	Notes
CellCount	positiveInteger	Number of cells in the grid. Must be positive.

Derived From: AbstractGridRepresentation

Derived Classes: (none)

7.3.62.2 Relationships

Role	Class	Cardinality
Geometry	UnstructuredGridGeometry	0..1

7.3.63 UnstructuredSubnodeTopology

Stereotypes: XSDcomplexType

If edge subnodes are used, then edges must be defined. If cell subnodes are used, nodes per cell must be defined.

Derived From: SubnodeTopology

Derived Classes: (none)

7.3.63.1 Relationships

Role	Class	Cardinality
Edges	Edges	0..1
NodesPerCell	NodesPerCell	0..1

7.3.64 VariableSubnodePatch

Stereotypes: XSDcomplexType

If the number of subnodes per data-object are variable for each data-object, use this subnode construction.

7.3.64.1 Attributes

Name	Data Type	Notes
ObjectIndices	AbstractIntegerArray	Indices of the selected data-objects
SubnodeCountPerSelectedObject	AbstractIntegerArray	Number of subnodes per selected data-object.

Derived From: SubnodePatch

Derived Classes: (none)

Relationships: None

7.4 Structural Representations

Representations are the digital descriptions of a feature interpretation or a technical feature. This representation is based on a topology and contains the geometry of the digital description or is based on the topology or the geometry of another representation. Structural has two types of representations:

- **Representation of Individual Representations**. Each Individual representation is specialized by dimension (point, polyline, surface, volume) and represents only one individual geological interpretation (such as, horizons, faults, geological bodies, geological units, and fluids units).
- **Representation of Organization Representations**. Each organization representations is a consistent assembly of different representations of interpretations of organizations (such as, earth model, structural organization, stratigraphic organizations, stratigraphic columns, and fluid organizations).

7.4.1 LineRole

Indicates the various roles that a polyline topology can have in a representation.

Name	Data Type	Notes
fault center line	External Reference	Usually used to represent fault lineaments on horizons. These lines can represent nonsealed contact interpretation parts defined by a horizon/fault intersection.
pick	External Reference	Used to represent all types of nonsealed contact interpretation parts defined by a horizon/fault

Name	Data Type	Notes
		intersection.
inner ring		Closed polyline that delineates a hole in a surface patch.
outer ring		Closed polyline that delineates the extension of a surface patch.
trajectory		Polyline that is used to represent a well trajectory representation.
interpretation line		Line corresponding to a digitalization along an earth model section.
contact		Used to represent nonsealed contact interpretation parts defined by a horizon/fault intersection.
depositional line		Used to represent nonsealed contact interpretation parts defined by a horizon/horizon intersection.
erosion line		Used to represent nonsealed contact interpretation parts defined by a horizon/horizon intersection.
contouring		Used to obtain sets of 3D x, y, z points to represent any boundary interpretation.
pillar		

7.4.2 SurfaceRole

Indicates the various roles that a surface topology can have.

Name	Data Type	Notes
map		Representation support for properties.
pick		Representation support for 3D points picked in 2D or 3D.

7.4.3 AbstractContactRepresentationPart

Stereotypes: XSDcomplexType

Parent class of the sealed and non-sealed contact elements.

7.4.3.1 Attributes

Name	Data Type	Notes
Index	nonNegativeInteger	The index of the contact. Indicates identity of the contact in the surface framework context. It is used for contact identities and to find the interpretation of this particular contact.

Derived From: (none)

Derived Classes: ContactRepresentationReference, SealedContactRepresentationPart, NonSealedContactRepresentationPart

Relationships: None

7.4.4 AbstractSurfaceFrameworkRepresentation

Stereotypes: XSDcomplexType

Parent class for a sealed or non-sealed surface framework representation. Each one instantiates a representation set representation.

The difference between the sealed and non-sealed frameworks is that, in the non-sealed case, we do not have all of the contact representations, or we have all of the contacts but they are not all sealed.

Derived From: RepresentationSetRepresentation

Derived Classes: SealedSurfaceFrameworkRepresentation, NonSealedSurfaceFrameworkRepresentation

7.4.4.1 Relationships

Role	Class	Cardinality
ContactIdentity	ContactIdentity	0..*

7.4.5 AbstractSurfaceRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Parent class of structural surface representations, which can be bounded by an outer ring and has inner rings. These surfaces may consist of one or more patches.

7.4.5.1 Attributes

Name	Data Type	Notes
SurfaceRole	SurfaceRole	

Derived From: AbstractRepresentation

Derived Classes: Grid2dSetRepresentation, Grid2dRepresentation, PlaneSetRepresentation, TriangulatedSetRepresentation

7.4.5.2 Relationships

Role	Class	Cardinality
Boundaries	PatchBoundaries	0..*

7.4.6 ContactIdentity

Stereotypes: XSDcomplexType

Indicates identity between two (or more) contacts. For possible types of identities, see IdentityKind.

7.4.6.1 Attributes

Name	Data Type	Notes
IdentityKind	IdentityKind	
ListOfContactRepresentations	AbstractIntegerArray	The contact representations that share common identity as specified by their indices.
ListOfIdenticalNodes	AbstractIntegerArray	Indicates which nodes (identified by their common index in all contact representations) of the contact representations are identical. If this list is not present, then it indicates that all nodes in each representation are identical, on an element by element level.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.4.7 ContactPatch

Stereotypes: XSDcomplexType

A subset of topological elements of an existing contact representation part (sealed or non-sealed contact).

7.4.7.1 Attributes

Name	Data Type	Notes
RepresentationIndex	nonNegativeInteger	Identifies a representation by its index, in the list of representations contained in the organization.
SupportingRepresentationNodes	AbstractIntegerArray	The ordered list of nodes (identified by their global index) in the supporting representation, which constitutes the contact patch.

Derived From: Patch1d

Derived Classes: (none)

Relationships: None

7.4.8 ContactRepresentationReference

Stereotypes: XSDcomplexType

Used when the contact already exists as a top level element representation.

Derived From: AbstractContactRepresentationPart

Derived Classes: (none)

7.4.8.1 Relationships

Role	Class	Cardinality
Representation	AbstractRepresentation	1..1

7.4.9 EdgePatch

Stereotypes: XSDcomplexType

Describes edges that are not linked to any other edge. Because edges do not have indices, a consecutive pair of nodes is used to identify each edge.

The split edges dataset is a set of nodes (2 nodes per edge). Each patch has a set of 2 nodes.

7.4.9.1 Attributes

Name	Data Type	Notes
SplitEdges	AbstractIntegerArray	An array of split edges to define patches. It points to an HDF5 dataset, which must be a 2D array of non-negative integers with dimensions 2 x numSplitEdges. integers with dimensions {2, numSplitEdges}.

Derived From: Patch1d

Derived Classes: (none)

Relationships: None

7.4.10 Grid2dPatch

Stereotypes: XSDcomplexType

Patch representing a single 2D grid and its geometry.

The FastestAxisCount and the SlowestAxisCount determine the indexing of this grid 2D patch, by defining a one dimensional index for the 2D grid as follows:

Index = FastestIndex + FastestAxisCount * SlowestIndex

This indexing order IS the data order when stored in HDF5, in which case, this would be a SlowestAxisCount*FastestAxisCount two-dimensional array in HDF5.

7.4.10.1 Attributes

Name	Data Type	Notes
SlowestAxisCount	positiveInteger	The number of nodes in the slowest direction.
FastestAxisCount	positiveInteger	The number of nodes in the fastest direction.

Derived From: Patch

Derived Classes: (none)

7.4.10.2 Relationships

Role	Class	Cardinality
Geometry	PointGeometry	1..1

7.4.11 Grid2dRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Representation based on a 2D grid. For definitions of slowest and fastest axes of the array, see Grid2dPatch.

Derived From: AbstractSurfaceRepresentation

Derived Classes: (none)

7.4.11.1 Relationships

Role	Class	Cardinality
Grid2dPatch	Grid2dPatch	1..1

7.4.12 Grid2dSetRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Set of representations based on a 2D grid. Each 2D grid representation corresponds to one patch of the set.

Derived From: AbstractSurfaceRepresentation

Derived Classes: (none)

7.4.12.1 Relationships

Role	Class	Cardinality
Grid2dPatch	Grid2dPatch	2..*

7.4.13 NodePatch

Stereotypes: XSDcomplexType

Patch representing a list of nodes to which geometry may be attached.

Derived From: Patch1d

Derived Classes: (none)

7.4.13.1 Relationships

Role	Class	Cardinality
Geometry	PointGeometry	1..1

7.4.14 NonSealedContactRepresentationPart

Stereotypes: XSDcomplexType

Defines a non-sealed contact representation, meaning that this contact representation is defined by a geometry.

Derived From: AbstractContactRepresentationPart

Derived Classes: (none)

7.4.14.1 Relationships

Role	Class	Cardinality
Contact	ContactPatch	0..*
Geometry	AbstractGeometry	1..1

7.4.15 NonSealedSurfaceFrameworkRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A collection of contact representations parts, which are a list of contact patches with no identity. This collection of contact representations is completed by a set of representations gathered at the representation set representation level.

Derived From: AbstractSurfaceFrameworkRepresentation

Derived Classes: (none)

7.4.15.1 Relationships

Role	Class	Cardinality
NonSealedContactRepresentation	AbstractContactRepresentationPart	0..*

7.4.16 OrientedMacroFace

Stereotypes: XSDcomplexType

An element of a volume shell that is defined by a set of oriented faces belonging to boundable patches.

A macroface may describe a contact between:

- two structural, stratigraphic, or fluid units.
- one boundary feature (fault or frontier) and a unit.

A face is a bounded open subset of a plane or a curved surface in 3D, delimited by an outer contour and zero, one, or more inner contours describing holes.

7.4.16.1 Attributes

Name	Data Type	Notes
PatchIndexOfRepresentation	nonNegativeInteger	Creates the triangulation and 2D grid representation for which the patches match the macrofaces.
RepresentationIndex	nonNegativeInteger	Identifies the representation by its index, in the list of representations contained in the organization.
SideIsPlus	boolean	

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.4.17 PatchBoundaries

Stereotypes: XSDcomplexType

Defines the boundaries of an indexed patch. These boundaries are outer and inner rings.

7.4.17.1 Attributes

Name	Data Type	Notes
InnerRing	DataObjectReference	A hole inside a representation patch. Inside the ring, the representation patch is not defined, outside it is. In case of contact, inner ring polyline representations should be typed as an erosion line, deposition line, or contact. BUSINESS RULE: Must be a polyline reference to a polyline representation, either a single polyline representation or a subrepresentation. Must be closed.
OuterRing	DataObjectReference	The extension of a representation patch. Inside the ring, the representation patch is defined, outside it is not. BUSINESS RULE: Must be a reference to a polyline, either a single polyline representation or a subrepresentation. Must be closed.
ReferencedPatch	nonNegativeInteger	UUID of the referenced topological patch.

Derived From: (none)

Derived Classes: (none)

Relationships: None

7.4.18 PlaneSetRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Defines a plane representation, which can be made up of multiple patches. Commonly represented features are fluid contacts or frontiers. Common geometries of this representation are titled or horizontal planes.

BUSINESS RULE: If the plane representation is made up of multiple patches, then you must specify the outer rings for each plane patch.

Derived From: AbstractSurfaceRepresentation

Derived Classes: (none)

7.4.18.1 Relationships

Role	Class	Cardinality
Planes	AbstractPlaneGeometry	1..*

7.4.19 PointSetRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A representation that consists of one or more node patches. Each node patch is an array of XYZ coordinates for the 3D points. There is no implied linkage between the multiple patches.

Derived From: AbstractRepresentation

Derived Classes: (none)

7.4.19.1 Relationships

Role	Class	Cardinality
NodePatch	NodePatch	1..*

7.4.20 PolylineRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A representation made up of a single polyline or "polygonal chain", which may be closed or not.

Definition from Wikipedia (http://en.wikipedia.org/wiki/Piecewise_linear_curve):

A polygonal chain, polygonal curve, polygonal path, or piecewise linear curve, is a connected series of line segments. More formally, a polygonal chain *P* is a curve specified by a sequence of points \scriptstyle(A_1, A_2, \dots, A_n) called its vertices so that the curve consists of the line segments connecting the consecutive vertices.

In computer graphics a polygonal chain is called a polyline and is often used to approximate curved paths.

BUSINESS RULE: To record a polyline the writer software must give the values of the geometry of each node in an order corresponding to the logical series of segments (edges). The geometry of a polyline must be a 1D array of points.

A simple polygonal chain is one in which only consecutive (or the first and the last) segments intersect and only at their endpoints.

A closed polygonal chain (isClosed=True) is one in which the first vertex coincides with the last one, or the first and the last vertices are connected by a line segment.

7.4.20.1 Attributes

Name	Data Type	Notes
LineRole	LineRole	
IsClosed	boolean	

Derived From: AbstractRepresentation

Derived Classes: (none)

7.4.20.2 Relationships

Role	Class	Cardinality
NodePatch	NodePatch	1..1

7.4.21 PolylineSetPatch

Stereotypes: XSDcomplexType

A patch containing a set of polylines.

For performance reasons, the geometry of each patch is described in only one 1D array of 3D points, which aggregates the nodes of all the polylines together.

To be able to separate the polyline descriptions, additional information is added about the type of each polyline (closed or not) and the number of 3D points (node count) of each polyline.

This additional information is contained in two arrays, which are associated with each polyline set patch. The dimension of these arrays is the number of polylines gathered in one polyline set patch.

- The first array contains a Boolean for each polyline (closed or not closed).
- The second array contains the count of nodes for each polyline.

7.4.21.1 Attributes

Name	Data Type	Notes
ClosedPolylines	AbstractBooleanArray	
NodeCountPerPolyline	AbstractIntegerArray	The first number in the list defines the node count for the first polyline in the polyline set patch. The second number in the list defines the node count for the second polyline in the polyline set patch. etc.

Derived From: Patch

Derived Classes: (none)

7.4.21.2 Relationships

Role	Class	Cardinality
Geometry	PointGeometry	1..1

7.4.22 PolylineSetRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A representation made up of a set of polylines or a set of polygonal chains (for more information, see PolylineRepresentation).

For compactness, it is organized by line patch as a unique polyline set patch.

if allPolylineClosed = True, all the polylines are connected between the first and the last point.

Its geometry is a 1D array of points, corresponding to the concatenation of the points of all polyline points.

7.4.22.1 Attributes

Name	Data Type	Notes
LineRole	LineRole	

Derived From: AbstractRepresentation

Derived Classes: (none)

7.4.22.2 Relationships

Role	Class	Cardinality
LinePatch	PolylineSetPatch	1..*

7.4.23 SealedContactRepresentationPart

Stereotypes: XSDcomplexType

Sealed contact elements that indicate that 2 or more contact patches are partially or totally colocated or equivalent. For possible types of identity, see IdentityKind.

7.4.23.1 Attributes

Name	Data Type	Notes
IdentityKind	IdentityKind	
IdenticalNodeIndices	AbstractIntegerArray	Indicate which nodes (identified by their common index in all contact patches) of the contact patches are identical. If this list is not present, then it indicates that all nodes in each representation are identical, on an element-by-element level.

Derived From: AbstractContactRepresentationPart

Derived Classes: (none)

7.4.23.2 Relationships

Role	Class	Cardinality
Contact	ContactPatch	2..*

7.4.24 SealedSurfaceFrameworkRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A collection of contact representations parts, which are a list of contact patches and their identities. This collection of contact representations is completed by a set of representations gathered at the representation set representation level.

Derived From: AbstractSurfaceFrameworkRepresentation

Derived Classes: (none)

7.4.24.1 Relationships

Role	Class	Cardinality
SealedContactRepresentation	SealedContactRepresentationPart	0..*

7.4.25 SealedVolumeFrameworkRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A strict boundary representation (BREP), which represents the volume region by assembling together shells.

BUSINESS RULE: The sealed structural framework must be part of the same earth model as this sealed volume framework.

Derived From: RepresentationSetRepresentation

Derived Classes: (none)

7.4.25.1 Relationships

Role	Class	Cardinality
BasedOn	SealedSurfaceFrameworkRepresentation	1..1
Shells	VolumeShell	1..*
Regions	VolumeRegion	1..*

7.4.26 TrianglePatch

Stereotypes: XSDcomplexType

Patch made of triangles, where the number of triangles is given by the patch count.

BUSINESS RULE: Within a patch, all the triangles must be contiguous.

The patch contains:

- Number of nodes within the triangulation and their locations.
- 2D array describing the topology of the triangles.

Two triangles that are connected may be in different patches.

7.4.26.1 Attributes

Name	Data Type	Notes
NodeCount	nonNegativeInteger	
Triangles	AbstractIntegerArray	The triangles are a 2D array of non-negative integers with the dimensions 3 x numTriangles.

Derived From: Patch1d

Derived Classes: (none)

7.4.26.2 Relationships

Role	Class	Cardinality
Geometry	PointGeometry	1..1
SplitEdgePatch	EdgePatch	0..*

7.4.27 TriangulatedSetRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A representation based on set of triangulated mesh patches, which gets its geometry from a 1D array of points.

BUSINESS RULE: The orientation of all the triangles of this representation must be consistent.

Derived From: AbstractSurfaceRepresentation

Derived Classes: (none)

7.4.27.1 Relationships

Role	Class	Cardinality
TrianglePatch	TrianglePatch	1..*

7.4.28 VolumeRegion

Stereotypes: XSDcomplexType

The volume within a shell or envelope.

Known issue (2.0): This object should be considered a volume region patch. Specifically the indexable element kind = patch, despite not inheriting from a patch, with the patch index given by the contained element.

The volume region must be considered as a patch in version 2.0 (even if now, this volume region is not literally inheriting from the patch class).

7.4.28.1 Attributes

Name	Data Type	Notes
PatchIndex	nonNegativeInteger	This patch index is used to enumerate the volume regions. Known issue (2.0): Patch Index should inherit from patch, instead of being listed as a volume region element. Volume regions must be considered as a patch in version 2.0 (even if now, this volume region is not literally inheriting from the patch class).

Derived From: (none)

Derived Classes: (none)

7.4.28.2 Relationships

Role	Class	Cardinality
InternalShells	VolumeShell	0..*
Represents	GeologicUnitInterpretation	1..1
ExternalShell	VolumeShell	1..1

7.4.29 VolumeShell

Stereotypes: XSDcomplexType

The shell or envelope of a structural, stratigraphic, or fluid unit.

7.4.29.1 Attributes

Name	Data Type	Notes
ShellUid	string	

Derived From: (none)

Derived Classes: (none)

7.4.29.2 Relationships

Role	Class	Cardinality
MacroFaces	OrientedMacroFace	1..*

7.5 Well Representatios

The RESQML description of a well uses a wellbore trajectory representation to describe the geometry of a wellbore, and a wellbore frame to provide the topological support for properties. Wellbore marker frames and blocked wellbores are derived from the wellbore frame.

7.5.1 MdReference

Reference location for the measured depth datum (MdDatum).

The type of local or permanent reference datum for vertical gravity based (i.e., elevation and vertical depth) and measured depth coordinates within the context of a well. This list includes local points (e.g., kelly bushing) used as a datum and vertical reference datums (e.g., mean sea level).

Name	Data Type	Notes
ground level		
kelly bushing		
mean sea level		A tidal datum. The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch (19 years).
derrick floor		
casing flange		A flange affixed to the top of the casing string used to attach production equipment.
arbitrary point		This value should not be used for drilled wells. All reasonable attempts should be made to determine the appropriate value.
crown valve		
rotary bushing		

Name	Data Type	Notes
rotary table		
sea floor		
lowest astronomical tide		The lowest tide level over the duration of the National Tidal Datum Epoch (19 years).
mean higher high water		A tidal datum. The average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch (19 years).
mean high water		A tidal datum. The average of all the high water heights observed over the National Tidal Datum Epoch (19 years).
mean lower low water		A tidal datum. The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch (19 years).
mean low water		A tidal datum. The average of all the low water heights observed over the National Tidal Datum Epoch (19 years).
mean tide level		A tidal datum. The arithmetic mean of mean high water and mean low water. Same as half-tide level.
kickoff point		This value is not expected to be used in most typical situations. All reasonable attempts should be made to determine the appropriate value.

7.5.2 MdDomain

Different types of measured depths.

Name	Data Type	Notes
driller		The original depths recorded while drilling a well or LWD or MWD.
logger		Depths recorded when logging a well, which are in general considered to be more accurate than driller's depth.

7.5.3 GeologicBoundaryKind

The various geologic boundary a well marker can indicate.

Name	Data Type	Notes
fault		
geobody		
horizon		

7.5.4 WellboreFrameIndexableElements

The elements on a wellbore frame that may be indexed.

Name	Data Type	Notes
intervals		Count = nodeCount-1
nodes		Count = nodeCount
cells		Count = Number of intervals that intersect grids in the blocked wellbore. When applied to the wellbore frame representation, this is identical to the number of intervals.

7.5.5 FluidMarker

The various fluid a well marker can indicate.

Name	Data Type	Notes
gas down to		
gas up to		
oil down to		
oil up to		
water down to		
water up to		

7.5.6 BlockedWellboreRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

The information that allows you to locate, on one or several grids (existing or planned), the intersection of volume (cells) and surface (faces) elements with a wellbore trajectory (existing or planned).

7.5.6.1 Attributes

Name	Data Type	Notes
CellCount	nonNegativeInteger	The number of non-null entries in the grid indices array.
CellIndices	AbstractIntegerArray	The grid cell index for each blocked well cell. BUSINESS RULE: Array length must equal cell count.
GridIndices	AbstractIntegerArray	Size of array = IntervalCount. Null values of -1 signify that that interval is not within a grid. BUSINESS RULE: The cell count must equal the number of non-null entries in this array.
LocalFacePairPerCellIndices	AbstractIntegerArray	For each cell, these are the entry and exit faces of the trajectory. Use null (-1), for example, at TD when there is only one intersection. The local face-per-cell

Name	Data Type	Notes
		index is used because a global face index need not have been defined on the grid. BUSINESS RULE: The array dimensions must equal 2 x CellCount.

Derived From: WellboreFrameRepresentation

Derived Classes: (none)

7.5.6.2 Relationships

Role	Class	Cardinality
Grid	AbstractGridRepresentation	1..*

7.5.7 DeviationSurveyRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Specifies the station data from a deviation survey.

The deviation survey does not provide a complete specification of the geometry of a wellbore trajectory. Although a minimum-curvature algorithm is used in most cases, the implementation varies sufficiently that no single algorithmic specification is available as a data transfer standard.

Instead, the geometry of a RESQML wellbore trajectory is represented by a parametric line, parameterized by the MD.

CRS and units of measure do not need to be consistent with the CRS and units of measure for wellbore trajectory representation.

7.5.7.1 Attributes

Name	Data Type	Notes
AngleUom	PlaneAngleUom	Defines the units of measure for the azimuth and inclination
Azimuths	AbstractDoubleArray	An array of azimuth angles, one for each survey station. The rotation is relative to the projected CRS north with a positive value indicating a clockwise rotation as seen from above. If the local CRS--whether in time or depth--is rotated relative to the projected CRS, then the azimuths remain relative to the projected CRS not the local CRS. Note that the projection's north is not the same as true north or magnetic north. A good definition of the different kinds of "north" can be found in the OGP Surveying & Positioning Guidance Note 1 http://www.ogp.org.uk/pubs/373-01.pdf (the "True, Grid and Magnetic North bearings" paragraph). BUSINESS RULE: Array length equals station count.
FirstStationLocation	Point3d	XYZ location of the first station of the deviation survey.
Inclinations	AbstractDoubleArray	Dip (or inclination) angle for each station.

Name	Data Type	Notes
		BUSINESS RULE: Array length equals station count.
IsFinal	boolean	Used to indicate that this is a final version of the deviation survey, as distinct from the interim interpretations.
Mds	AbstractDoubleArray	MD values for the position of the stations. BUSINESS RULE: Array length equals station count.
MdUom	LengthUom	Units of measure of the measured depths along this deviation survey.
StationCount	positiveInteger	Number of stations.
WitsmlDeviationSurvey	DataObjectReference	

Derived From: AbstractRepresentation

Derived Classes: (none)

7.5.7.2 Relationships

Role	Class	Cardinality
MdDatum	MdDatum	1..1
TimeIndex	TimeIndex	0..1

7.5.8 MdDatum

Stereotypes: XSDcomplexType,XSDtopLevelElement

Specifies the location of the measured depth = 0 reference point.

The location of this reference point is defined with respect to a CRS, which need not be the same as the CRS of a wellbore trajectory representation, which may reference this location.

7.5.8.1 Attributes

Name	Data Type	Notes
Location	Point3d	The location of the MD reference point relative to a local CRS.
MdReference	MdReference	

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

7.5.8.2 Relationships

Role	Class	Cardinality
LocalCrs	AbstractLocal3dCrs	1..1

7.5.9 WellboreFrameRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Representation of a wellbore that is organized along a wellbore trajectory by its MD values. RESQML uses MD values to associate properties on points and to organize association of properties on intervals between MD points.

7.5.9.1 Attributes

Name	Data Type	Notes
NodeCount	positiveInteger	Number of nodes. Must be positive.
NodeMd	AbstractDoubleArray	MD values for each node. BUSINESS RULE: MD values and UOM must be consistent with the trajectory representation.
WitsmlLogReference	DataObjectReference	The reference to the equivalent WITSML well log.

Derived From: AbstractRepresentation

Derived Classes: WellboreMarkerFrameRepresentation, BlockedWellboreRepresentation

7.5.9.2 Relationships

Role	Class	Cardinality
IntervalStratigraphiUnits	IntervalStratigraphicUnits	0..1
CellFluidPhaseUnits	CellFluidPhaseUnits	0..1
Trajectory	WellboreTrajectoryRepresentation	1..1

7.5.10 WellboreMarker

Stereotypes: XSDcomplexType

Representation of a wellbore marker that is located along a wellbore trajectory, one for each MD value in the wellbore frame.

BUSINESS RULE: Ordering of the wellbore markers must match the ordering of the nodes in the wellbore marker frame representation.

7.5.10.1 Attributes

Name	Data Type	Notes
GeologicBoundaryKind	GeologicBoundaryKind	
FluidMarker	FluidMarker	
FluidContact	FluidContact	
WitsmlFormationMarker	DataObjectReference	Optional WITSML wellbore reference of the well marker frame.

Derived From: AbstractResqmlDataObject

Derived Classes: (none)

7.5.10.2 Relationships

Role	Class	Cardinality
Interpretation	BoundaryFeatureInterpretation	0..1

7.5.11 WellboreMarkerFrameRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

A well log frame where each entry represents a well marker

Derived From: WellboreFrameRepresentation

Derived Classes: (none)

7.5.11.1 Relationships

Role	Class	Cardinality
WellboreMarker	WellboreMarker	1..*

7.5.12 WellboreTrajectoryParentIntersection

Stereotypes: XSDcomplexType

For a wellbore trajectory in a multi-lateral well, indicates the MD of the kickoff point where the trajectory begins and the corresponding MD of the parent trajectory.

7.5.12.1 Attributes

Name	Data Type	Notes
KickoffMd	double	
ParentMd	double	

Derived From: (none)

Derived Classes: (none)

7.5.12.2 Relationships

Role	Class	Cardinality
ParentTrajectory	WellboreTrajectoryRepresentation	1..1

7.5.13 WellboreTrajectoryRepresentation

Stereotypes: XSDcomplexType,XSDtopLevelElement

Representation of a wellbore trajectory.

7.5.13.1 Attributes

Name	Data Type	Notes
StartMd	double	Specifies the measured depth for the start of the

Name	Data Type	Notes
		wellbore trajectory. Range may often be from kickoff to TD, but this is not necessary. BUSINESS RULE: Start MD is always less than the Finish MD.
FinishMd	double	Specifies the ending measured depth of the range for the wellbore trajectory. Range may often be from kickoff to TD, but this is not necessary. BUSINESS RULE: Start MD is always less than the Finish MD.
MdUom	LengthUom	The unit of measure of the reference MD.
WitsmlTrajectory	DataObjectReference	Pointer to the WITSML trajectory that is contained in the referenced wellbore. (For information about WITSML well and wellbore references, see the definition for RESQML technical feature, WellboreFeature).
MdDomain	MdDomain	

Derived From: AbstractRepresentation

Derived Classes: (none)

7.5.13.2 Relationships

Role	Class	Cardinality
Geometry	AbstractParametricLineGeometry	0..1
MdDatum	MdDatum	1..1
DeviationSurvey	DeviationSurveyRepresentation	0..1
ParentIntersection	WellboreTrajectoryParentIntersection	0..1

Appendix A. RESQML UOM

This appendix lists the RESQML units of measure from the Property package of the schema (see Section 6.4 (page 73)). Because the list is quite long, it was moved here. For more information about units of measure, see the *Energistics Unit of Measure Standard.* (For a link to related documents, see 1.4.1 (page 14).)

A.1 ResqmlUom

Name	Data Type	Notes
m3/km		
m3/kmol		
m3/kg		
m3/h		
m3/J		
m3/kPa		
m3/min		
m3/mol		
m3/m3		
m3/m		
m3/m2		
m3/(s.ft)		
m3/(s.m)		
m3/(psi.d)		
m3/(m3.K)		
m3/(Pa.s)		
m3/(s.m2)		
m3/d2		
m3/g		
m3/d		
m3/(s.m3)		
m3/bbl		
Ma[t]		
mbar		

Name	Data Type	Notes
mA/ft2		
MA		
mA/cm2		
MBq		
Mcal[th]		
mcal[th]		
mC/m2		
mC		
MC		
m3/s		
m3/s2		
m3/rev		
m3/Pa		
m3/rad		
m3/t		
m4/s		
mA		
m4		
m3/ton[UK]		
m3/ton[US]		
m3/(kW.h)		
m/kPa		
m/m		
m/km		
m/K		
m/kg		
m/m3		
m/s		

Name	Data Type	Notes
m/s2		
m/Pa		
m/min		
m/ms		
lm/W		
lx		
lm/m2		
lm		
lm.s		
lx.s		
m/d		
m/h		
m/cm		
m		
m/(m.K)		
m3/(bar.d)		
m3/(bar.h)		
m3		
m2/mol		
m2/s		
m3/(bar.min)		
m3/(kPa.d)		
m3/(kPa.h)		
m3/(ha.m)		
m3/(d.m)		
m3/(h.m)		
m2/(Pa.s)		
m2/cm3		

Name	Data Type	Notes
m2/(kPa.d)		
m[Ger]		
m2		
m2/d		
m2/m2		
m2/m3		
m2/kg		
m2/g		
m2/h		
mCi		
MJ		
mJ		
mina		
min/ft		
min/m		
MJ/a		
MJ/m		
mJ/m2		
MJ/kmol		
mJ/cm2		
MJ/kg		
mi[US]2		
mi2		
mi[US]		
mi[naut]		
mi[nautUK]		
mi3		
mila		

Name	Data Type	Notes
min		
mil/a		
Mibyte		
mil		
mm3/J		
mmHg[0degC]		
mm3		
mm2/mm2		
mm2/s		
mmol		
mN/km		
mN/m		
mN.m2		
mN		
MN		
mL/gal[US]		
mL/mL		
mL/gal[UK]		
MJ/m3		
mL		
Mm		
mm/s		
mm2		
mm/a		
mm		
mm/(mm.K)		
mi/in		
mg		

Name	Data Type	Notes
Mg/a		
Mg		
MF		
mF		
Mg/d		
Mg/h		
Mg/in		
mg/gal[US]		
mg/dm3		
mg/g		
mD.in2/(lbf.s)		
mD.m		
mD.ft2/(lbf.s)		
mD		
mD.ft		
mD/(Pa.s)		
meV		
MeV		
mEuc		
mD/cP		
MEuc		
mH		
MH		
MGy		
mgn		
mGy		
mHz		
mi/gal[US]		

Name	Data Type	Notes
mi/h		
mi/gal[UK]		
MHz		
mi		
Mg/m2		
mg/m3		
mg/L		
mg/J		
mg/kg		
Mg/m3		
Mgauss		
Mgf		
mgauss		
Mg/min		
mGal		
link[US]		
km/cm		
km/dm3		
km		
klbm/in		
klx		
km/h		
km3		
kmol		
km2		
km/L		
km/s		
kJ/(kg.K)		

Name	Data Type	Notes
kJ/(kmol.K)		
kJ/(h.m2.K)		
kJ		
kJ.m/(h.m2.K)		
kJ/dm3		
klbf		
klbm		
kJ/m3		
kJ/kg		
kJ/kmol		
kPa/h		
kPa/hm		
kPa.s/m		
kP		
kPa		
kPa/m		
kpsi		
kpsi2		
kPa2/cP		
kPa/min		
kPa2		
kN		
kN.m		
kmol/s		
kmol/h		
kmol/m3		
kN.m2		
kohm		

Name	Data Type	Notes
kohm.m		
knot		
kN/m		
kN/m2		
Kibyte		
kg/dm4		
kg/h		
kg/dm3		
kg/(m2.s)		
kg/d		
kg/J		
kg/m2		
kg/m3		
kg/m		
kg/kg		
kg/L		
kF		
kg		
keV		
kdyne		
kEuc		
kg.m		
kg/(kW.h)		
kg/(m.s)		
kg.m2		
kg.m/cm2		
kg.m/s		
kgf/cm		

Name	Data Type	Notes
kgf/cm2		
kgf.s/m2		
kgf.m/m		
kgf.m2		
kgf/kgf		
kH		
kHz		
kGy		
kgf/m2		
kgf/mm2		
kg/mol		
kg/s		
kg/MJ		
kg/m4		
kg/min		
kg/sack[94lbm]		
kgf.m		
kgf.m/cm2		
kgf		
kg/t		
kgauss		
krad		
lbm/(gal[UK].ft)		
lbm/(gal[US].ft)		
lbm/(ft2.s)		
lbm/(ft.s)		
lbm/(ft2.h)		
lbm/(hp.h)		

Name	Data Type	Notes
lbm/ft2		
lbm/ft3		
lbm/ft		
lbm/bbl		
lbm/d		
lbf/in		
lbf/lbf		
lbf/gal[US]		
lbf/ft2		
lbf/ft3		
lbm		
lbm.ft2/s2		
lbm/(ft.h)		
lbm.ft2		
lbm.ft		
lbm.ft/s		
lbmol/h		
lbmol/s		
lbmol/gal[US]		
lbmol/ft3		
lbmol/gal[UK]		
link		
link[Se]		
link[SeT]		
link[Cla]		
link[BnA]		
link[BnB]		
lbm/h		

Name	Data Type	Notes
lbm/in3		
lbm/gal[US]		
lbm/ft4		
lbm/gal[UK]		
lbm/lbmol		
lbmol/(h.ft2)		
lbmol/(s.ft2)		
lbmol		
lbm/min		
lbm/s		
lbf/ft		
kW/m2		
kW/m3		
kW/cm2		
kW/(m2.K)		
kW/(m3.K)		
kWb		
L/kg		
L/kmol		
L/h		
L		
L/(bar.min)		
kT		
kV		
kS/m		
krd		
kS		
kW		

Name	Data Type	Notes
kW.h/kg		
kW.h/m3		
kW.h/dm3		
kW.h		
kW.h/(kg.degC)		
lbf.ft/lbm		
lbf.ft/min		
lbf.ft/in2		
lbf.ft/gal[US]		
lbf.ft/in		
lbf.ft/s		
lbf.s/ft2		
lbf.s/in2		
lbf.in2		
lbf.in		
lbf.in/in		
L/mol		
L/s		
L/min		
L/m		
L/m3		
L/s2		
lbf.ft		
lbf.ft/bbl		
lbf		
L/t		
L/ton[UK]		
Mohm		

Name	Data Type	Notes
ton[UK]/a		
ton[UK]/d		
ton[UK]		
TN		
Tohm		
ton[UK]/h		
ton[US]/d		
ton[US]/ft2		
ton[US]/a		
ton[UK]/min		
ton[US]		
TH		
therm[EC]		
TGy		
Tg		
Tgauss		
therm[UK]		
TJ/a		
Tm		
TJ		
therm[US]		
THz		
tonf[US]/in2		
tonRefrig		
tonf[US]/ft2		
tonf[US].mi/ft		
tonf[US]/ft		
torr		

Name	Data Type	Notes
TS		
TT		
Trd		
TP		
TPa		
tonf[UK].ft2		
tonf[UK]/ft		
tonf[UK]		
ton[US]/h		
ton[US]/min		
tonf[UK]/ft2		
tonf[US].mi		
tonf[US].mi/bbl		
tonf[US].ft2		
tonf[US]		
tonf[US].ft		
TF		
s/m3		
s/qt[UK]		
S/m		
s/L		
s/m		
s/qt[US]		
section		
sr		
seca		
s/s		
sack[94lbm]		

Name	Data Type	Notes
rpm/s		
s		
rpm		
rev/s		
rod[US]		
S		
s/in		
s/kg		
s/ft3		
s/cm		
s/ft		
TBq		
TC		
Ta[t]		
t/min		
TA		
Tcal[th]		
TEuc		
TeV		
TD[API]/(Pa.s)		
TD[API]		
TD[API].m		
Sv/s		
t		
Sv/h		
St		
Sv		
T		

Name	Data Type	Notes
T/m		
t/m3		
t/h		
t/a		
t/d		
TV		
W/(m.K)		
W/(m2.K)		
W.m2.K/(J.K)		
V/m		
W		
W/(m2.sr)		
W/kW		
W/m2		
W/K		
W/(m3.K)		
W/cm2		
uV/ft		
uV/m		
uV		
us/m		
uT		
uW		
V/B		
V/dB		
V		
uW/m3		
uWb		

Name	Data Type	Notes
yd[Ind37]		
yd[Ind62]		
yd[Ind]		
yd[BnB]		
yd[Cla]		
yd[Ind75]		
yd2		
yd3		
yd[US]		
yd[Se]		
yd[SeT]		
W/W		
Wb		
W/sr		
W/m3		
W/mm2		
Wb.m		
yd		
yd[BnA]		
wk		
Wb/m		
Wb/mm		
us/in		
uF		
uF/m		
ueV		
uCi		
uEuc		

Name	Data Type	Notes
ug		
ugauss		
uGy		
ug/mg		
ug/cm3		
ug/g		
uA		
uA/cm2		
TWb		
TW		
TW.h		
uA/in2		
ucal[th]/(s.cm2)		
ucal[th]/s		
ucal[th]		
ubar		
uC		
uP		
uPa		
uohm/m		
uohm		
uohm/ft		
upsi		
us		
us/ft		
uS		
urad		
urd		

Name	Data Type	Notes
uJ		
um		
uHz		
uH		
uH/m		
um/s		
umol		
uN		
umHg[0degC]		
um2		
um2.m		
rev/m		
nA		
na		
N/N		
N/m3		
N/mm2		
nAPI		
nEuc		
neV		
nCi		
nC		
ncal[th]		
MWb		
N		
mWb		
MW.h/m3		
mW/m2		

Name	Data Type	Notes
N.m		
N/m		
N/m2		
N.s/m2		
N.m/m		
N.m2		
nohm.mm2/m		
nP		
nohm.mil2/ft		
nN		
nohm		
nPa		
ns/ft		
ns/m		
ns		
nrd		
nS		
ng/mg		
ngauss		
ng/g		
nF		
ng		
nGy		
nm		
nm/s		
nJ		
nH		
nHz		

Name	Data Type	Notes
MW.h/kg		
MPa/h		
MPa/m		
MPa.s/m		
mPa		
mPa.s		
Mpsi		
mrd		
mrem		
Mrd		
mrad		
Mrad		
mol/(s.m2)		
mol/m2		
mol.m2/(mol.s)		
mohm		
mol		
mol/m3		
mP		
MPa		
MP		
mol/mol		
mol/s		
mT/dm		
MV		
mT		
mSv		
mSv/h		

Name	Data Type	Notes
mV		
MW		
MW.h		
mW		
mV/ft		
mV/m		
ms		
ms/cm		
mS		
mrem/h		
MS		
mS/cm		
mS/m		
ms/s		
ms/m		
ms/ft		
ms/in		
nT		
psi/ft		
psi/h		
psi.s		
psi		
psi.d/bbl		
psi/m		
psi2/cP		
pT		
psi2.d/(cP.ft3)		
psi/min		

Name	Data Type	Notes
psi2		
ppm		
ppm[mass]		
ppk		
pP		
pPa		
ppm[vol]		
ps		
pS		
prd		
ppm[vol]/degC		
ppm[vol]/degF		
rad/m3		
rad/s		
rad/m		
rad/ft		
rad/ft3		
rad/s2		
rev		
rev/ft		
rem/h		
rd		
rem		
pV		
pW		
pt[US]		
pt[UK]		
pt[UK]/(hp.h)		

Name	Data Type	Notes
pWb		
quad/a		
rad		
quad		
qt[UK]		
qt[US]		
pohm		
pA		
Pa		
P		
ozm		
ozm[troy]		
Pa.s		
Pa/h		
Pa/m		
Pa.s2/m3		
Pa.s.m3/kg		
Pa.s/m3		
O		
Oe		
nWb		
nV		
nW		
ohm		
ohm/m		
ozf		
ohm.m2/m		
ohm.cm		

Name	Data Type	Notes
ohm.m		
pF		
pg		
peV		
pdl/cm		
pEuc		
pgauss		
pm		
pN		
pJ		
pGy		
pHz		
Pa2/(Pa.s)		
pC		
Pa2		
Pa/m3		
Pa/s		
pcal[th]		
pdl.cm2		
pdl.ft		
pdl		
pCi		
pCi/g		
Btu[IT]/gal[UK]		
Btu[IT]/gal[US]		
Btu[IT]/ft3		
Btu[IT]/(s.ft3.degF)		
Btu[IT]/bbl		

Name	Data Type	Notes
Btu[IT]/h		
Btu[IT]/s		
Btu[th]		
Btu[IT]/min		
Btu[IT]/lbm		
Btu[IT]/lbmol		
Btu[IT]/(h.m2.degC)		
Btu[IT]/(hp.h)		
Btu[IT]/(h.ft3.degF)		
Btu[IT]/(h.ft2.degR)		
Btu[IT]/(h.ft3)		
Btu[IT]/(lbm.degF)		
Btu[IT]/(s.ft2.degF)		
Btu[IT]/(s.ft3)		
Btu[IT]/(s.ft2)		
Btu[IT]/(lbm.degR)		
Btu[IT]/(lbmol.degF)		
ca		
cal[IT]		
cA		
C/mm2		
C/mm3		
cal[th]		
cal[th]/(h.cm2.degC)		
cal[th]/(h.cm3)		
cal[th]/(h.cm2)		
cal[th]/(g.K)		
cal[th]/(h.cm.degC)		

Name	Data Type	Notes
C		
C.m		
byte/s		
Btu[UK]		
byte		
C/cm2		
C/m2		
C/m3		
C/kg		
C/cm3		
C/g		
Btu[IT]/(h.ft2.degF)		
bbl/(acre.ft)		
bbl/(d.acre.ft)		
bbl		
bar2		
bar2/cP		
bbl/(d.ft)		
bbl/acre		
bbl/bbl		
bbl/(psi.d)		
bbl/(ft.psi.d)		
bbl/(kPa.d)		
B.W		
b/cm3		
B		
atm/m		
b		

Name	Data Type	Notes
B/m		
bar/km		
bar/m		
bar/h		
B/O		
bar		
bit		
bit/s		
Bd		
bbl/ton[UK]		
bbl/ton[US]		
Bq		
Btu[IT]/(h.ft.degF)		
Btu[IT]/(h.ft2)		
Btu[IT].in/(h.ft2.degF)		
Bq/kg		
Btu[IT]		
bbl/ft3		
bbl/h		
bbl/ft		
bbl/d		
bbl/d2		
bbl/h2		
bbl/min		
bbl/psi		
bbl/mi		
bbl/in		
bbl/m3		

Name	Data Type	Notes
cal[th]/(mol.degC)		
ct		
cT		
cSt		
cs		
cS		
cu		
cwt[UK]		
cwt[US]		
cWb		
cV		
cW		
cm3/s		
cm4		
cm3/min		
cm3/L		
cm3/m3		
cmH2O[4degC]		
cPa		
crd		
cP		
cN		
cohm		
dAPI		
dB		
daN.m		
dam		
daN		

Name	Data Type	Notes
dB.MW		
dB/km		
dB/m		
dB/ft		
dB.mW		
dB.W		
D.m		
D/(Pa.s)		
D.ft		
D		
d		
d/bbl		
D[API]		
dA		
d/m3		
D/cP		
d/ft3		
cm3/h		
cd/m2		
cEuc		
cd		
ccal[th]		
ccgr		
ceV		
cgr		
cGy		
cgauss		
cF		

Name	Data Type	Notes
cg		
cal[th]/cm3		
cal[th]/g		
cal[th]/(s.cm3)		
cal[th]/(s.cm.degC)		
cal[th]/(s.cm2.degC)		
cal[th]/h		
cal[th]/mm3		
cC		
cal[th]/mL		
cal[th]/kg		
cal[th]/lbm		
cm/s		
cm/s2		
cm/a		
cJ		
cm		
cm2		
cm3/cm3		
cm3/g		
cm3		
cm2/g		
cm2/s		
chain[BnB]		
chain[Cla]		
chain[BnA]		
cH		
chain		

Name	Data Type	Notes
chain[Ind37]		
cHz		
Ci		
chain[US]		
chain[Se]		
chain[SeT]		
atm/hm		
1/bbl		
1/cm		
1/bar		
1/a		
1/angstrom		
1/d		
1/ft		
1/ft2		
1/degR		
1/degC		
1/degF		
1/30 cm3/min		
1/30 dega/ft		
1/2 ms		
1/16 in		
1/2 ft		
1/30 dega/m		
1/32 in		
1/64 in		
1/30 N/m		
1/30 lbf/m		

Name	Data Type	Notes
1/30 m/m		
1/m		
1/m2		
1/lbm		
1/L		
1/lbf		
1/m3		
1/mm		
1/ms		
1/min		
1/mi		
1/mi2		
1/gal[US]		
1/H		
1/gal[UK]		
1/ft3		
1/g		
1/h		
1/km2		
1/kPa		
1/kg		
1/in		
1/K		
1/(kg.s)		
0.001 gal[US]/ft3		
0.001 gal[US]/gal[US]		
0.001 gal[US]/bbl		
0.001 gal[UK]/bbl		

Name	Data Type	Notes
0.001 gal[UK]/gal[UK]		
0.001 h/ft		
0.001 lbm/gal[US]		
0.001 psi/ft		
0.001 lbm/gal[UK]		
0.001 kPa2/cP		
0.001 lbm/bbl		
%[molar]		
%[vol]		
%[mass]		
%		
%[area]		
(bbl/d)/(bbl/d)		
0.001 bbl/m3		
0.001 d/ft3		
0.001 bbl/ft3		
(m3/d)/(m3/d)		
(m3/s)/(m3/s)		
0.1 ft		
0.1 ft[US]		
0.01 psi/ft		
0.01 lbf/ft2		
0.01 lbm/ft2		
0.1 gal[US]/bbl		
0.1 pt[US]/bbl		
0.1 yd		
0.1 lbm/bbl		
0.1 in		

Name	Data Type	Notes
0.1 L/bbl		
0.01 dega/ft		
0.01 degF/ft		
0.01 bbl/bbl		
0.001 pt[UK]/bbl		
0.001 seca		
0.01 dm3/km		
0.01 L/km		
0.01 lbf/ft		
0.01 L/kg		
0.01 ft/ft		
0.01 grain/ft3		
1/N		
1E-6 m3/(m3.degF)		
1E6 m3/d		
1E-6 m3/(m3.degC)		
1E6 lbm/a		
1E6 m3		
1E-9 1/ft		
30 m		
a		
30 ft		
1E9 bbl		
1E9 ft3		
1E-6 bbl/m3		
1E6 Btu[IT]		
1E-6 bbl/ft3		
1E6 bbl/acre		

Name	Data Type	Notes
1E6 bbl/d		
1E6 Btu[IT]/h		
1E6 ft3/d		
1E-6 gal[US]		
1E6 ft3/bbl		
1E6 ft3		
1E6 ft3/(acre.ft)		
acre.ft		
ag		
acre		
A/mm2		
a[t]		
aJ		
atm/ft		
atm/h		
atm		
angstrom		
at		
A.s		
A.s/kg		
A.m2		
A		
A.h		
A.s/m3		
A/m2		
A/mm		
A/m		
A/cm2		

Name	Data Type	Notes
A/ft2		
1E6 bbl/(acre.ft)		
10 kN		
10 Mg/m3		
10 km		
10 ft		
10 in		
100 ft		
1000 bbl.ft/d		
1000 bbl/d		
1000 bbl		
100 ka[t]		
100 km		
1/psi		
1/s		
1/pPa		
1/nm		
1/Pa		
1/upsi		
1/wk		
1/yd		
1/V		
1/us		
1/uV		
1000 m3/d		
1000 m3/h		
1000 m3/(h.m)		
1000 m3		

Name	Data Type	Notes
1000 m3/(d.m)		
1000 m3/m3		
1E-6 acre.ft/bbl		
1E6 bbl		
1E6 (ft3/d)/(bbl/d)		
1000 m4/d		
1E12 ft3		
1000 ft3		
1000 ft3/(d.ft)		
1000 ft/s		
1000 ft		
1000 ft/h		
1000 ft3/(psi.d)		
1000 gal[US]		
1000 lbf.ft		
1000 gal[UK]		
1000 ft3/bbl		
1000 ft3/d		
dB/O		
gAPI		
gauss		
gal[US]/ton[US]		
gal[US]/sack[94lbm]		
gal[US]/ton[UK]		
gauss/cm		
GEuc		
GeV		
Gcal[th]		

Name	Data Type	Notes
GBq		
GC		
gal[US]/ft		
gal[US]/ft3		
gal[US]/d		
gal[US]/(min.ft2)		
gal[US]/bbl		
gal[US]/h		
gal[US]/min		
gal[US]/min2		
gal[US]/mi		
gal[US]/h2		
gal[US]/lbm		
GPa		
GPa/cm		
GP		
Gohm		
gon		
GPa2		
Grd		
GS		
grain/gal[US]		
grain		
grain/ft3		
Ggauss		
GGy		
Gg		
GF		

Name	Data Type	Notes
gf		
GH		
gn		
GN		
Gm		
GHz		
GJ		
gal[US]/(min.ft)		
g/gal[US]		
g/kg		
g/gal[UK]		
g/cm4		
g/dm3		
g/L		
g/t		
GA		
g/s		
g/m3		
g/mol		
fur[US]		
fV		
ft3/sack[94lbm]		
ft3/s		
ft3/s2		
fW		
g.m/(cm3.s)		
g/cm3		
g.ft/(cm3.s)		

Name	Data Type	Notes
fWb		
g		
gal[UK]/mi		
gal[UK]/min		
gal[UK]/lbm		
gal[UK]/h		
gal[UK]/h2		
gal[UK]/min2		
gal[US]/(h.in)		
gal[US]/(h.in2)		
gal[US]/(h.ft2)		
gal[US]		
gal[US]/(h.ft)		
gal[UK]/(h.ft)		
gal[UK]/(h.ft2)		
gal[UK]		
Ga[t]		
Gal		
gal[UK]/(h.in)		
gal[UK]/d		
gal[UK]/ft3		
gal[UK]/(min.ft2)		
gal[UK]/(h.in2)		
gal[UK]/(min.ft)		
GT		
J/K		
J/kg		
J/g		

Name	Data Type	Notes
J/cm2		
J/dm3		
J/m		
J/s		
K		
J/mol		
J/m2		
J/m3		
inHg[60degF]		
J		
inHg[32degF]		
inH2O[39degF]		
inH2O[60degF]		
J.m/(s.m2.K)		
J/(mol.K)		
J/(s.m2.degC)		
J/(kg.K)		
J.m/m2		
J/(g.K)		
kcal[th]/(kg.degC)		
kcal[th]/cm3		
kcal[th]/(h.m2.degC)		
kcal[th].m/cm2		
kcal[th]/(h.m.degC)		
kcal[th]/g		
kcal[th]/mol		
kcd		
kcal[th]/m3		

Name	Data Type	Notes
kcal[th]/h		
kcal[th]/kg		
K/m		
K/Pa		
K/km		
K.m2/kW		
K.m2/W		
K/s		
kC		
kcal[th]		
ka[t]		
K/W		
kA		
in4		
hg		
hL		
hbar		
ha		
ha.m		
hm		
hp.h/bbl		
hp.h/lbm		
hp.h		
hN		
hp		
GWb		
Gy		
GW.h		

Name	Data Type	Notes
GV		
GW		
H		
H/m		
h/m3		
h/km		
h		
h/ft3		
in/s2		
in[US]		
in/s		
in/a		
in/min		
in2		
in3		
in3/ft		
in2/s		
in2/ft2		
in2/in2		
hp[hyd]		
hp[hyd]/in2		
hp[elec]		
hp/ft3		
hp/in2		
hp[metric]		
in		
in/(in.degF)		
Hz		

Name	Data Type	Notes
hp[metric].h		
hs		
ft3/rad		
dyne		
dyne.cm2		
dWb		
dV		
dW		
dyne.s/cm2		
Ea[t]		
EC		
EA		
dyne/cm		
dyne/cm2		
dN.m		
dohm		
dN		
dm3/s2		
dm3/t		
dP		
dS		
dT		
ds		
dPa		
drd		
EP		
EPa		
Eohm		

Name	Data Type	Notes
Em		
EN		
Erd		
erg/cm3		
erg/g		
erg/cm2		
erg		
erg/a		
EF		
Eg		
EeV		
Ecal[th]		
EEuc		
Egauss		
EJ		
EJ/a		
EHz		
EGy		
EH		
dm3/s		
degC/kPa		
degC/m		
degC/km		
degC/h		
degC/hm		
degC/min		
degF/ft		
degF/h		

Name	Data Type	Notes
degF.ft2.h/Btu[IT]		
degC/s		
degF		
dega/ft		
dega/h		
dega		
dC		
dcal[th]		
dega/m		
degC.m2.h/kcal[th]		
degC/ft		
degC		
dega/min		
dega/s		
dm/s		
dm3		
dm		
dHz		
dJ		
dm3/(kW.h)		
dm3/m3		
dm3/MJ		
dm3/m		
dm3/kg		
dm3/kmol		
degF/s		
degR		
degF/psi		

Name	Data Type	Notes
degF/m		
degF/min		
dEuc		
dGy		
dH		
dgauss		
deV		
dF		
erg/kg		
ft[Ind]		
ft[Ind37]		
ft[GC]		
ft[Br65]		
ft[Cla]		
ft[Ind62]		
ft[US]		
ft2		
ft[SeT]		
ft[Ind75]		
ft[Se]		
ft/ms		
ft/psi		
ft/min		
ft/m		
ft/mi		
ft/s		
ft[BnB]		
ft[Br36]		

Name	Data Type	Notes
ft[BnA]		
ft/s2		
ft/us		
ft3/ft3		
ft3/h		
ft3/ft2		
ft3/d2		
ft3/ft		
ft3/h2		
ft3/min		
ft3/min2		
ft3/lbmol		
ft3/kg		
ft3/lbm		
ft2/s		
ft3		
ft2/lbm		
ft2/h		
ft2/in3		
ft3/(d.ft)		
ft3/bbl		
ft3/d		
ft3/(s.ft2)		
ft3/(ft.psi.d)		
ft3/(min.ft2)		
ft/lbm		
fEuc		
feV		

Name	Data Type	Notes
fcal[th]		
fathom		
fC		
fF		
fH		
fHz		
fGy		
fg		
fgauss		
Euc		
eV		
ET		
erg/m3		
ES		
EW		
fa		
fA		
F/m		
EWb		
F		
ft/bbl		
ft/d		
fT		
fS		
ft		
ft/degF		
ft/h		
ft/in		

Name	Data Type	Notes
ft/gal[US]		
ft/ft		
ft/ft3		
fm		
fN		
floz[US]		
fJ		
floz[UK]		
fohm		
fPa		
frd		
fP		
footcandle		
footcandle.s		