International Association of Oil & Gas Producers

Geomatics 462 series Data models note 1

Guidelines for the use of the Seabed Survey Data Model

Revision history

Version	Date	Amendments
1	April 2011	Initial release
1.1	March 2013	Re-design of figure 1 to match report 462-02

1 Introduction

This technical guidance note describes the Seabed Survey Data Model (SSDM), a specification used in the oil and gas exploration & production (E&P) industry in handling the delivery of various seabed survey datasets in GIS data format. The SSDM consists of the following material which is available from http://info.ogp.org.uk/geomatics:

- ESRI geodatabase template – a data model template to be used for the storage and exchange of GIS seabed survey data deliverables
- Data dictionary – a spreadsheet which details and describes the different components of the SSDM geodatabase template
- ArcGIS stylesheet – standardised symbology library for the features stored in the geodatabase. This can be used to create symbolized layer files and standardised maps
- Conceptual data model diagrams – used to help illustrate the architecture of the SSDM data model
- User and contractor guidelines – basic guidelines for how survey companies and E&P companies can utilise the SSDM
- ArcSDE SSDM implementation guide – guide for how to implement the SSDM data model schema into an O&G companies corporate database (ArcSDE). This compliments the workflow where companies receive deliverables in a standardised template that can be loaded to the corporate database after the data is quality controlled
- Frequently asked question document – a document that aims to answer the regular questions (generally non-technical) that are often asked about the SSDM.

2 Background

E&P companies aim to manage seabed survey data based on sound geo-information management principles and practices. Historically, geographical features interpreted from seabed survey have been delivered in unstructured CAD files that have led to many difficulties in the management of survey data. These issues include the fact that data from different surveys has been difficult to integrate and share with joint venture partners.

In view of these needs, the OGP SSDM task force was formed in 2010 to define a standard GIS data model for seabed survey. The SSDM template is provided in ESRI geodatabase format as most E&P companies widely utilise ESRI software for geo-information management and mapping, however, in principle the SSDM can be implemented on any GIS and transferred via an open GIS data exchange format.

3 Areas of application

The SSDM models survey project details (extents, equipment coverage, tracklines etc), hydrographic, shallow geophysical and geotechnical geographical entities and attributes; including surface and subsurface geologic hazards that are interpreted from seabed surveys.

At the present time, the main areas of the SSDM application are:

1. Platform and drilling hazard site surveys – shallow geophysical and high-resolution 2D/3D seismic.
2. Sweep and bathymetric surveys – side scan sonar and singlebeam/multibeam echosounder.
3. Pipeline route surveys, pipeline span/surveillance/inspection surveys using side scan sonar, but excluding ROV based pipeline inspection survey.

The role of the SSDM in pipeline inspection survey is limited, and existing data models (APDM/PPDM/PODS/Pipeline Operators Forum) for ROV inspection survey domain are available. It is recognised that seabed surveys are often carried out on or around existing infrastructure and installations in the field. The infrastructure and installation component is left undefined in the SSDM and the SSDM is expected to be used in conjunction with existing data models (e.g. APDM) that have been adopted by an E&P company, in order to capture the full range of acquired data and referenced data sets.

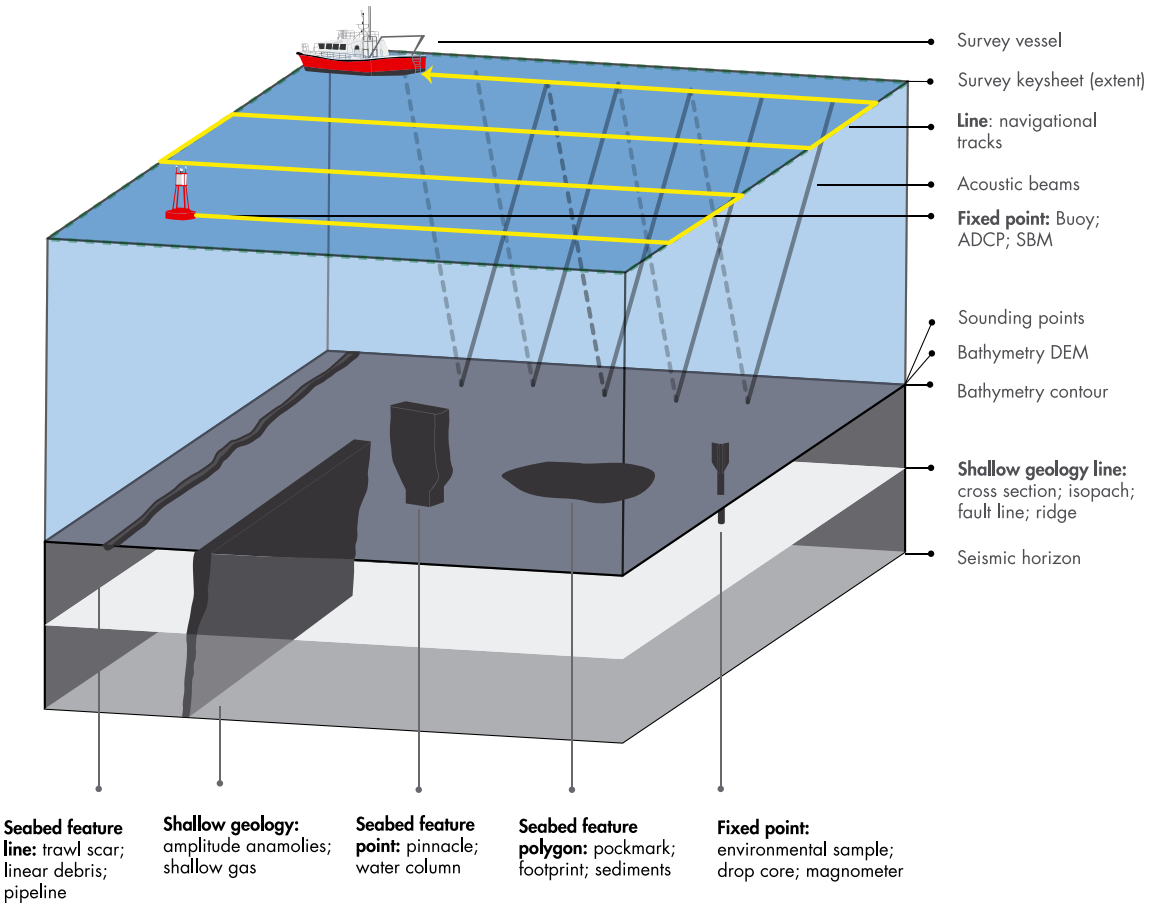


Figure 1: The conceptual framework diagram of the Seabed Survey Data Model

4 General recommendations

The following are general recommendations for the use of the OGP SSDM:

Data Modelling and Government

1. The OGP geomatics committee, represented by the OGP SSDM task force, is the governing body for the OGP SSDM. The task force defines the core data model and maintains a data dictionary (registry) of feature datasets, feature classes, feature subtypes and symbology codes.
2. For an E&P company, the core SSDM *must* be implemented to constitute a valid OGP SSDM implementation. However, E&P company may extend the data model (feature datasets, feature classes, feature subtypes and feature attributes) to address their company specific requirements.

Format of Data Exchange

1. The OGP SSDM Version 1 template is based on the ESRI geodatabase.
2. E&P company *may* choose to use ESRI geodatabase or define its own physical implementation of the SSDM on a specific GIS data format as long as it is in compliance with the core SSDM.

Application Tools

1. No restriction on the use of GIS and CAD systems as long as they fully support the OGP SSDM.

Symbology

1. The OGP SSDM task force *shall* assign and maintain a list of the subtype codes for the SSDM feature classes.
2. Currently, the OGP SSDM task force provides a sample set of ESRI styles for the SSDM, but E&P company *may* create their own cartographic symbology based on the subtype coded values.

Metadata

1. ISO 19115 metadata standard is recommended but E&P company *may* choose a specific metadata standard in conjunction with their native GIS data format.
2. The OGP SSDM provides a minimum set of feature level metadata. E&P company *may* extend the feature level metadata to meet their requirements.

5 SSDM Conceptual Model

Object and Feature

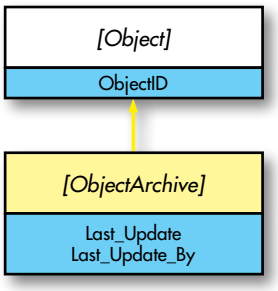
The SSDM conceptual model is presented in object diagrams common to geodatabase data modeling processes. The object diagram is used to depict classes, attributes of classes, object inheritance and relationships.

A class is defined as either an Abstract or Concrete class, where the top level class is an *Object*, which can be directly mapped to an ESRI simple object. *Feature* is an abstract class that defines the geometry of a geographical object, which can be mapped to an ESRI Shape in the ESRI geodatabase context. In GML context, an *Object* is a GML Feature, where as the SSDM *Feature* is the Geometry property of the GML Feature. While GML provides a much richer range of Geometry types, the SSDM implementation on geodatabase would be limited by ESRI Shape.

The SSDM abstract classes such as *Feature*, *FeatureArchive* and the *SSDMSurveyObject* describe the core attributes within the SSDM that must be inherited and created in the concrete classes. Concrete classes are best understood as the Feature Classes or Object Classes in the ESRI geodatabase.

FeatureArchive/objectArchive

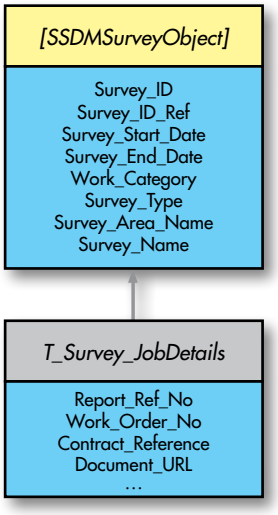
FeatureArchive or *ObjectArchive* defines the metadata required for history tracking and for archiving. For simplicity, in the core SSDM definition there are only two essential attributes being the date of editing and the editor's name and these are provided in the template. Like in other cases, although the core SSDM *must* be implemented to constitute a valid OGP SSDM implementation, E&P company *may* extend attributes of *Feature/ObjectArchive* to address their company specific requirements.

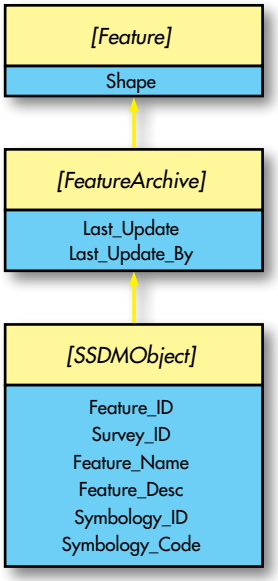


SSDMSurveyObject

This is the most important abstract class, which represents a seabed survey project. The primary key (survey_id or survey_id_ref) is used throughout the SSDM objects as a Foreign Key to identify the relationship for all geographic features created from a particular seabed survey project.

SSDMSurveyObject defines the basic attributes of a survey project, such as the survey project name, type of survey (i.e. debris survey, pipeline route survey etc), geographic area name, survey work category (i.e. analogue, digital) and start/end dates. It is then 'instantiated' as T_Survey_JobDetails, which is a database table in the SSDM template. More company relevant attributes are provided here, such as Report Reference number, Work Order number etc. This is where a lot of flexibility is provided to individual E&P company to make the SSDM suit their requirements.





SSDMObject

SSDMObject is an abstract class that provides the basic definition for all of the SSDM geographic objects. It is used by Survey Measurements, Seabed Features, and Environmental Sample classes. It is used to uniquely identify and describe a geographic object that is acquired, processed or interpreted from seabed survey data, such as fix positions (track lines), sounding points, and individual pockmark features. Core attributes are Feature Identifier (GUID), Feature Name, Feature Description text, Feature Subtype Identifier and Symbology Code.

SSDMGeohazardObject

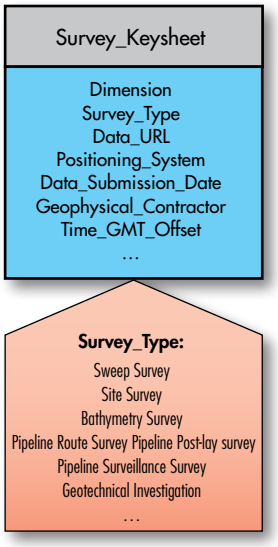
SSDMGeohazardObject share the core attributes of *SSDMObject* and additional attributes to describe geological units or layers as a result of interpretation from shallow high resolution seismic (pinger, boomer, chirper) and intermediate geological zones (HR2D seismic) from seabed survey. These include Reflector Numbers (e.g. R1, R2), Unit (e.g. Unit A, Unit B) and Horizon Name (e.g. H10, H20). However, it is expected that the geological concept and unit definition used in a site survey are described outside of the SSDM. There is room for integration with a full Geological Data Model in the future.

SSDMEnvObject

Similar to *SSDMObject*, the *SSDMEnvObject* provides the attributes for environmental samples. A minor difference is that instead of *Feature_Name* and *Feature_Desc*, it is called *Sample_Name* and *Sample_Desc*.

Concrete Classes and Feature Subtypes

From the *SSDMObject*, concrete classes are created and these are feature classes in the ESRI geodatabase. There are seven feature classes in Survey Measurements, and six feature classes in Seabed Features. One example of this would be the *Survey_Keysheet* in the Survey Measurements group of classes. Survey_Keysheet is a feature class that provides the indicative geographic extent of a survey project. It can be a polygon or a complex polygon depending on the actual implementation. In the SSDM template, ESRI simple polygon shape is used.



In a practical sense, the SSDM feature classes are limited by the ESRI basic Shape type (point, polyline and polygon), as such, a particular simple geometry is chosen based on the most frequently used type in the E&P industry. Although for the conceptual diagramming the concrete classes are inherited from *SSDMObject*, which is inherited from the *Feature*, the type of geometry used is decided at concrete class level and not logically depicted in the diagram. For example, in the Survey Measurements classes, the *Survey_Keysheet* is a 2D Polygon, and the *Survey_Tracklines* is a Polyline ZM (a 3D and measured value enabled feature class). Different types of geometry exist despite being inherited from the same top level object.

The SSDM Feature Subtypes are also common on the SSDM diagrams (see Figures 1-4). The concept of a subtype is part of the ESRI geodatabase data modeling philosophy. Feature Subtypes is a subset of a feature and it facilitates the creation of real objects that share the same object type. For example, the *Survey_Keysheet* carries subtypes such as Sweep/Debris Survey, Site Survey, Pipeline Route Survey etc, which are all different types of survey but they all belong to an indicative geographic extent for a survey project. Feature Subtypes is uniquely coded within the bounds of a Concrete Class and is maintained by the SSDM Task Force in a registry (dictionary). The E&P company must co-ordinate the allocation of new Subtype Code with the SSDM Task Force in order to avoid duplication.

Feature Datasets

The ESRI geodatabase provides a way for collecting related Feature Classes into a Feature Dataset. The Feature Classes in a Feature Dataset share a common co-ordinate reference system (CRS), but the Feature Dataset is also used to contain topologies, relationship classes, feature-linked annotation, geometry networks and terrains. This unique feature is used in the SSDM template to provide clarity to the SSDM where the Feature Classes are placed in the dataset based on the four groups of the SSDM Classes as described in the next section. This also provides an opportunity for the E&P company to set the topologies rules and relationship classes as required by their business processes.

SSDM Conceptual Model

The SSDM classes are grouped into Survey Measurements, Seabed Features, Shallow/Intermediate Geology Features and Environmental Sample Features.

Survey Measurements are classes related to survey project management, charts, and processed data acquired from survey instruments, such as the positioning system and fixes which are commonly presented as track lines at a specific interval of fixes.

Figure 1 is the diagram for Survey Measurements Classes. The following are the feature classes in this group:

- Survey Keysheet/Project Extents
- Proposed Survey Runlines
- Survey Track Lines
- Extents/Limits of Survey per Equipment Type
- Chart Series Bounding Boxes as Map Indexes
- Gridded Echo Sounding/Laser Ranging Spot Height/Depth Points
- Bathymetry Contours

As part of the concept diagram, Bathymetry DEM is also included to depict the use raster data for sea floor terrain in the SSDM. In principle, terrain data are either presented as contour lines or as a digital elevation model. The SSDM defines the surface data types in seabed survey (e.g. bathymetry, isopach, isochron, paleo-channel system) as contours and the E&P company has the option to also include a DEM in their survey delivery. Nonetheless, the naming convention for DEM raster data is not within scope of the current SSDM.

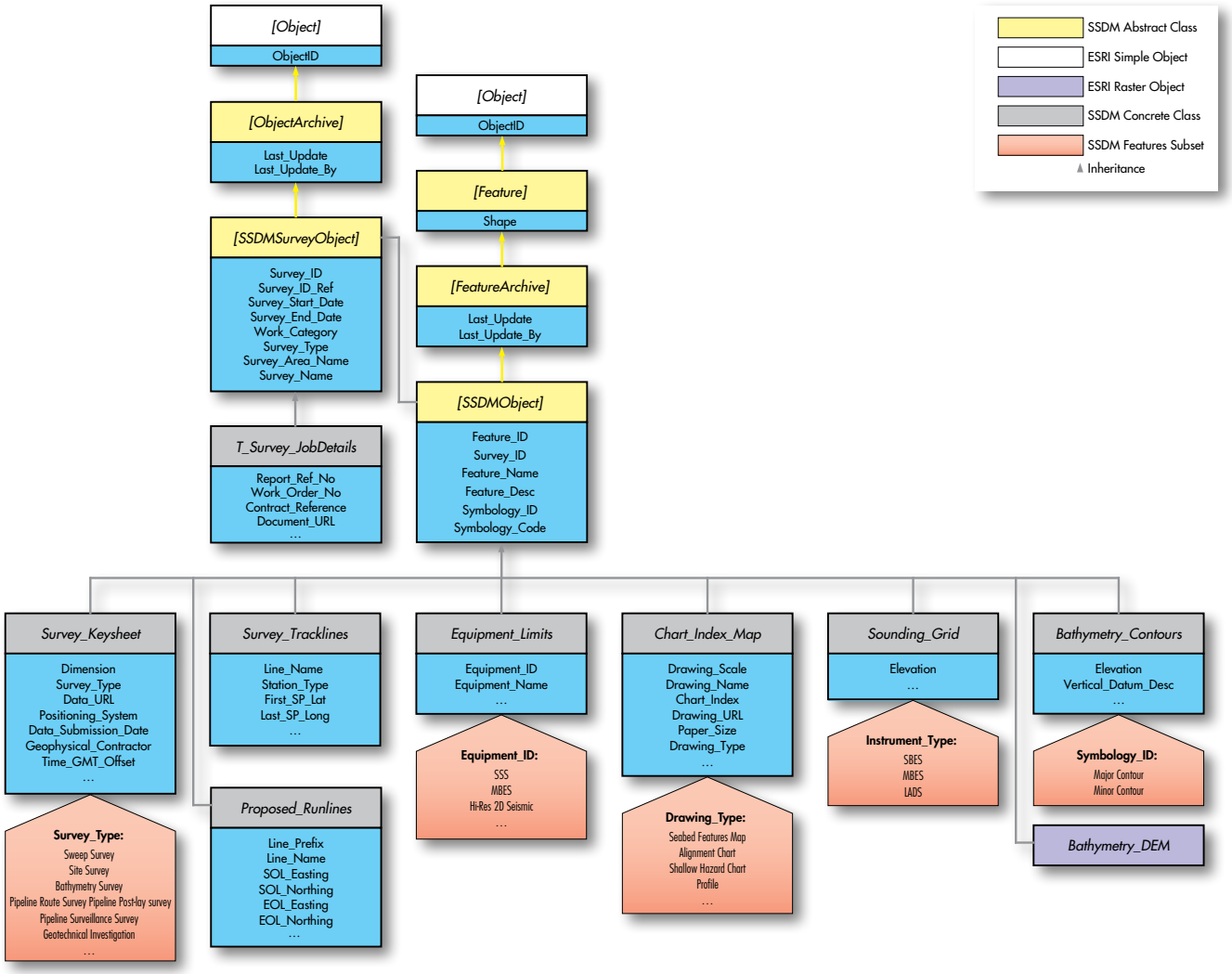


Figure 2: Survey Measurements Classes

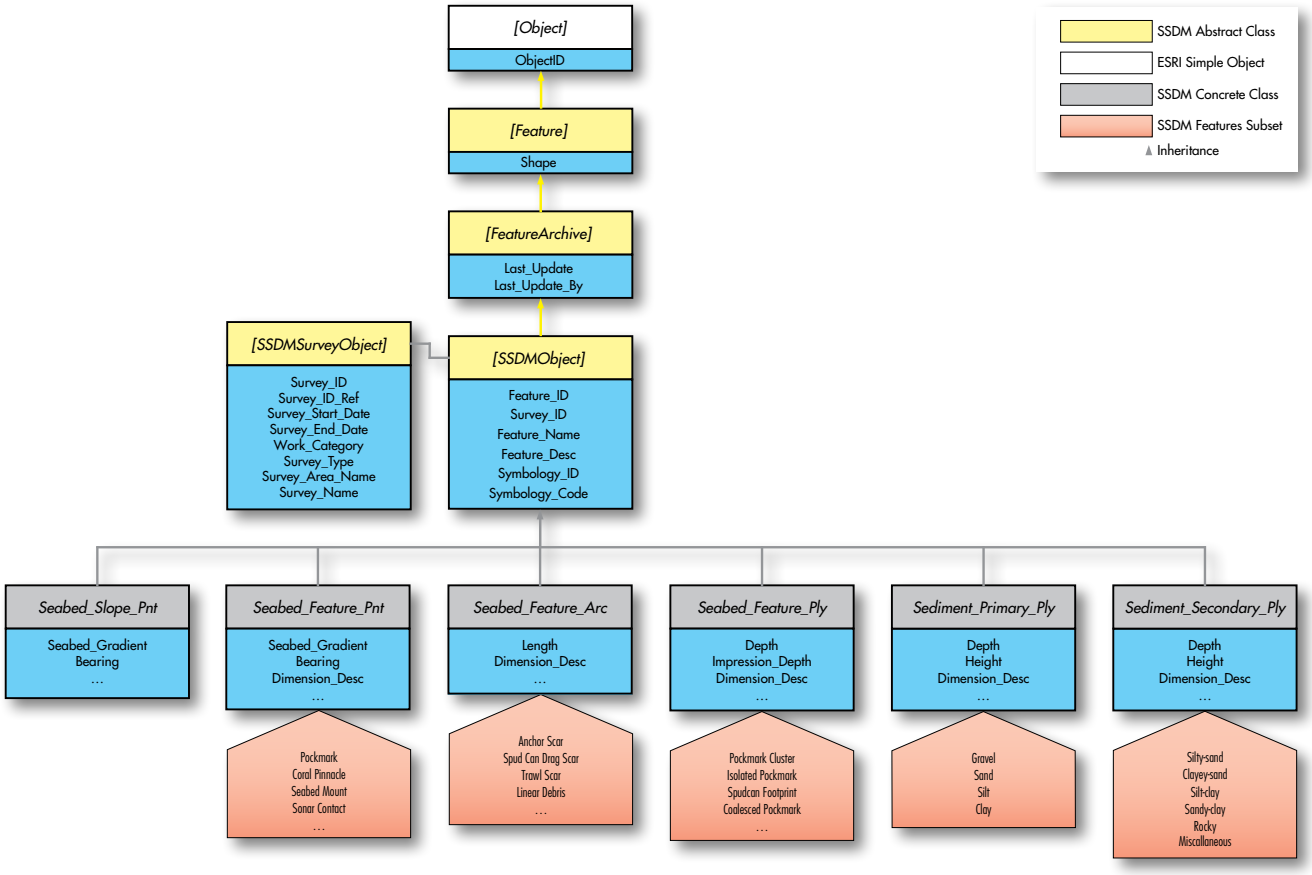


Figure 3: Seabed Feature Classes

Seabed Features comprises the main classes used in the SSDM. Almost every seabed survey required an interpretation of man-made or natural seabed features to be delivered. It is very often that some man-made or natural seabed features pose a risk to safe navigation and are eventually charted as seabed obstructions in admiralty or hydrographic charts. Below are the feature classes in this group:

- Seabed Features (points, lines and polygons)
- Slope Label Points
- Sediment – Primary
- Sediment – Secondary

Slope Label Points is a 'helper' class in the context of GIS cartography. It is common that slope analysis is performed on bathymetry data and locations with steep slope or high gradient are highlighted on the map. The Slope Label Points feature class provides a convenient table to hold the gradient data so that it can be labelled in the GIS view.

Primary and Secondary Sediment feature classes are also included in this group. The data source could be from seabed classification based on sonar backscatter, side-scan sonar, or interpolated using sediment data from geotechnical sampling/coring.

The Seabed Features Classes are as illustrated in Figure 3 above.

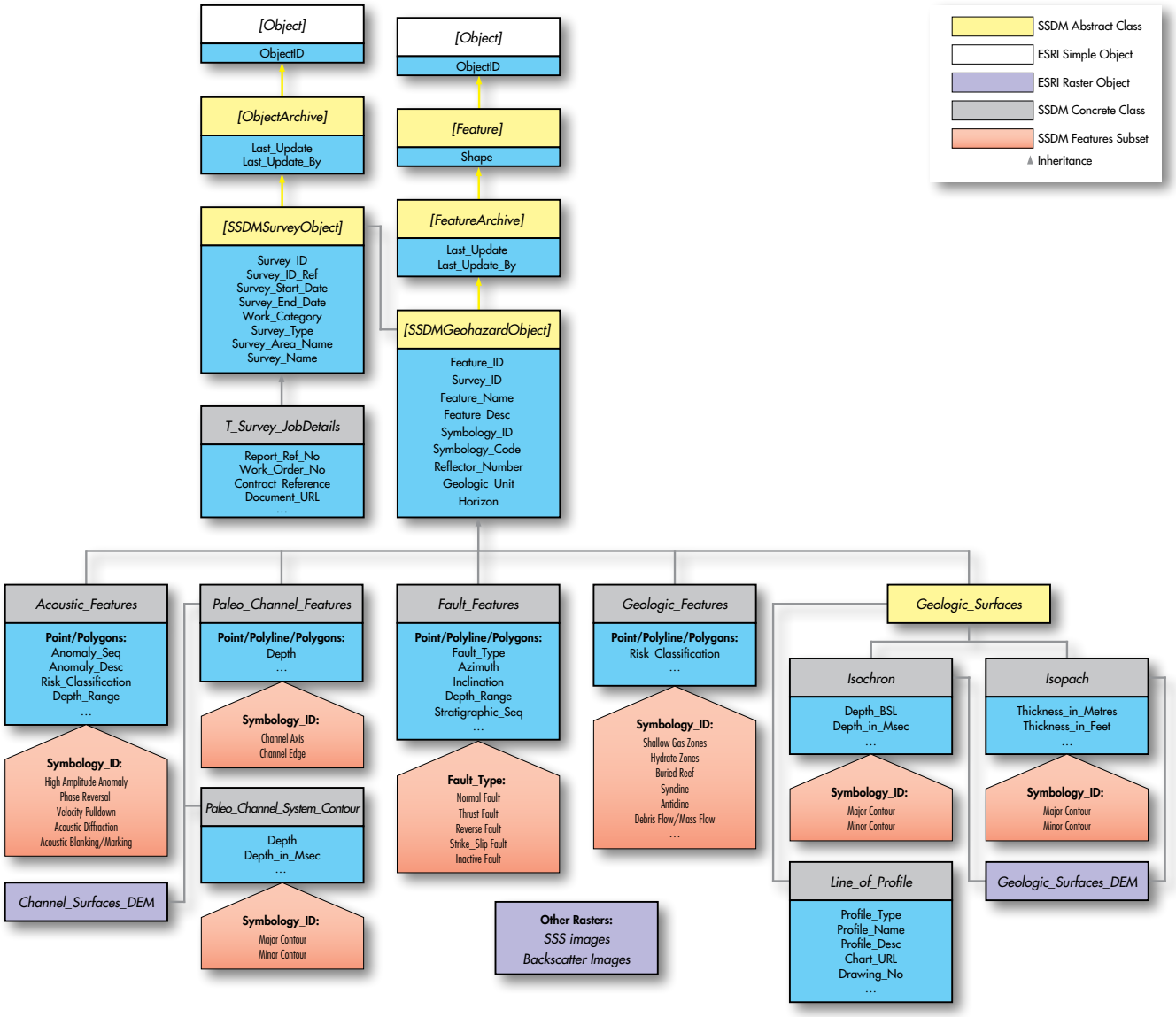


Figure 4: Shallow/Intermediate Geology (Geohazard) Feature Classes

The third group of feature classes are for Shallow and Intermediate Geology Features (Figure 4), which is also referred to as Geohazard features. One of the most important objectives of a seabed site survey is the identification of these features to help avoid geological hazards for drilling operations and the placement of infrastructure and facilities.

The feature classes comprise:

- Seismic Acoustic Features (anomalies)
- Paleo-Channels (points, lines, polygons and contours)
- Fault Features
- Geological Hazard Features (other than fault and channel)
- Geologic Surfaces – Isochron, Isopach
- Line of Profile/Section

Acoustic Features are seismic amplitude anomalies interpreted from the high resolution seismic images. Amplitude anomalies provide a good indication of the presence of shallow gas that can pose a risk to the drilling of wells and the pin-down of jack-up rigs.

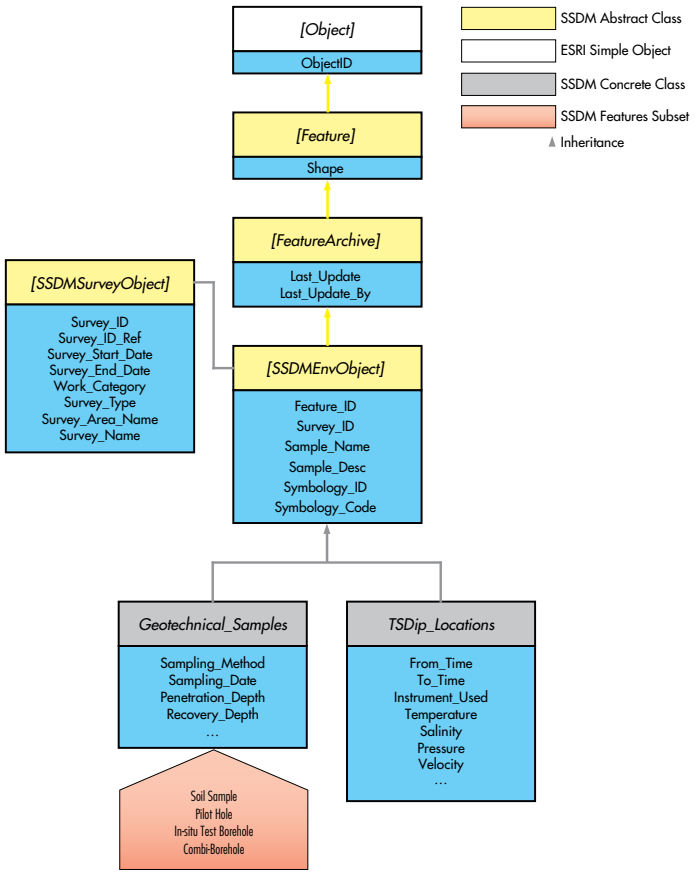
Geohazard features are either captured in specific classes for paleo-channels and faults, while all other hazards are captured in a common geological hazard feature class. As in the case of bathymetry, subsurface geological surfaces and seismic reflection are captured as Isochron or Isopach contours, and also as digital elevation models.

Like the Slope Label Points, Line of Profile is also a 'helper' class that assists in depicting the existence of a cross-section or seismic line section for the purpose of charting or for hyperlinking in a GIS environment.

Figure 5 depicts the smallest group of features in the SSDM - the Environmental Sample classes. The collection of Sound Velocity/ Temperature-Salinity (T-S Dip) Profiles is crucial in any hydrographic survey. E&P companies may chart the first measurement nearest to the sea surface only, or enter the whole series of Temperature-Salinity data at a specific interval, e.g. every one metre until the sea bottom.

Geotechnical Sample class caters for shallow samples such as soil sampling using drop core, grab or piston core, deeper coring such as seabed cone-penetration test (usually 10-30m depth from seabed), and also full geotechnical borehole, usually up to 150m depth. In the case of boreholes, the subtypes are available for in-situ test only, and combination of both soil sampling and in-situ test. Pilot hole is also a subset for Geotechnical Sample.

Figure 5: Environmental Sample (locations) Classes



6 Data Dictionary

The data dictionary provides the detailed definition of each Feature class, Object class and it also provides the list of feature subtypes in the SSDM.

The SSDM data dictionary is available on the OGP download site (see appendices).

7 Data Model Template

The SSDM template provided by the OGP SSDM task force is an ESRI personal geodatabase, structured and setup as follows:

- Contains thirty feature classes setup into four feature datasets (survey measurements, seabed features, shallow intermediate geology and environmental samples) and one geodatabase table called T_Survey_JobDetails for storing survey project related information e.g. assurance plans, contract numbers etc
- All feature datasets in the geodatabase are setup using the WGS84 geographic CRS. (see note on changing CRS)

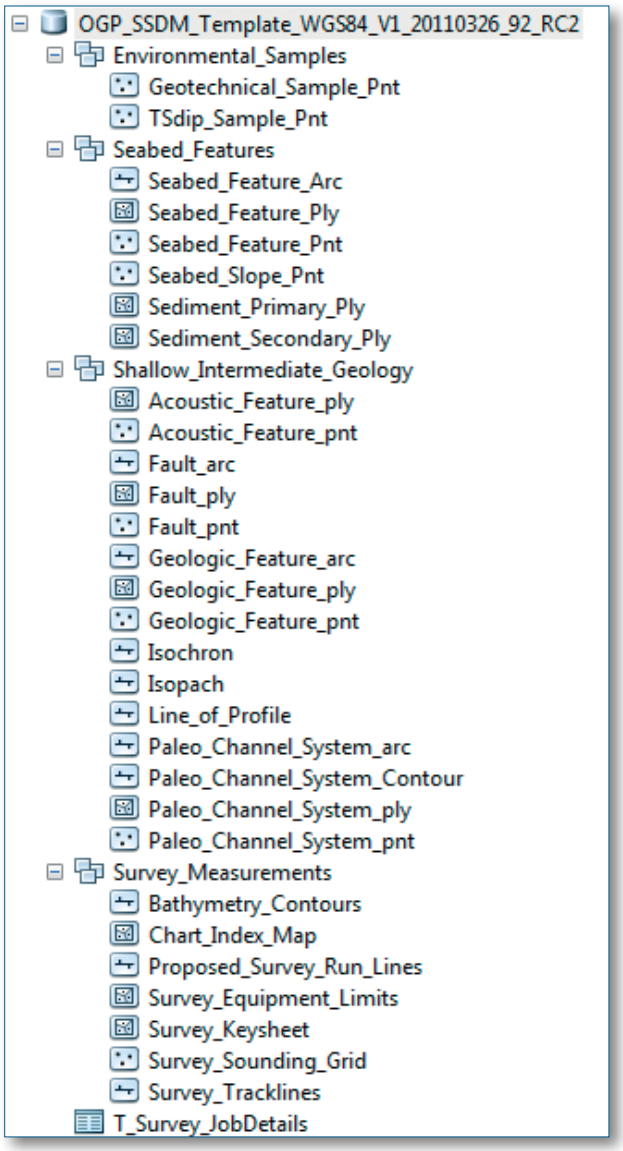


Figure 6: The OGP SSDM template in ArcCatalog

Please note that the type of geodatabase and the CRS the feature datasets are referenced to can be altered as per individual E&P company requirements. For example:

- The template could be setup as an ESRI personal geodatabase (MS Access based) or file geodatabase (non-MS Access based) whichever the E&P company would prefer.
- Although a CAD template has yet to be provided by OGP, the E&P company may choose to implement the data model on their selected CAD system capable of using a GIS data model, and provide their CAD-based SSDM template to the survey contractor.
- If an E&P company wishes to setup their template in another CRS this is achievable using the tools provided in ESRI ArcCatalog. Where an E&P company works over a large area or in a range of countries several templates should be setup for the area specific CRS's. For example:
  - WGS 84 UTM Zone 50 South
  - WGS 84 UTM Zone 51 South
  - WGS 84 UTM Zone 52 South

8 The Use of the SSDM Template

The SSDM template is typically used in the following manner:

- The E&P company implements the core OGP SSDM template and extends the template when necessary to include additional attributes, topology rules, relationship classes which can be company specific. The E&P company then issues the template to their survey contractor for a particular survey project or can embed it in their deliverable specifications (as part of a survey contractor framework agreement) so that it can be used routinely.
- The survey contractor first renames the template for the survey project, and populates the SSDM geodatabase either directly, or by data loading from other charting tools (e.g. CAD), and then completes the attribute entries. This is usually done by a GIS/CAD specialist. The geodatabase file is then submitted to the company together with other external files and data types, such as CAD drawings, XYZ, sonar images and SEG-Y.
- The same process is repeated for each survey project.
- At E&P company level, apart from the survey projects, the SSDM can be used as a template for implementation on a corporate GIS database, such as the ArcSDE geodatabase.

Figure 7: The OGP SSDM workflow from survey contractor to corporate delivery of seabed survey data

Please refer to the guideline documents on data loading and ArcSDE implementation.

9 References

1. ESRI, ArcGIS Pipeline Data Model Version 4.0, Technical Paper, 2007.
2. OGP Seabed Survey Data Model Task Force Discussion/Position Paper, June 2010.
3. OGP Seabed Survey Data Model – User and Contractor Guidelines, Oct 2010.
4. OGP Seabed Survey Data Model – ArcSDE Implementation Guide, Oct 2010.
5. OGP Seabed Survey Data Model – Frequently Asked Question (FAQ), Oct 2010.

10 Abbreviations

APDM
ArcGIS Pipeline Data Model

ESRI
Environment Systems Research Institute, Inc., owner of ArcGIS suite of software products.

CRS
Co-ordinate Reference System

DEM
Digital Elevation Model

E&P company
Oil & gas Exploration and Production company

GIS/CAD
Geographical Information System/Computer-Aided Drafting

GML
Geography Markup Language

GUID
Globally Unique Identifier

SSDM
Seabed Survey Data Model

O&G company
Oil & gas company

ROV
Remotely Operated Vehicle

11 Glossary of Terms

Core SSDM or Core Model
The core SSDM is the complete data model as supplied by the OGP geomatics committee, including all feature classes, tables, domains and subtypes. This includes the utilisation of the standard subtype and symbology codes. Without implementing these core components the model will not be considered a valid OGP SSDM implementation (as it won't easily translate to a valid OGP SSDM) which will defeat the purpose of having an industry standard data model.

Feature Subtype
Subtypes are a subset of features in a feature class, or objects in a table, that share the same attributes. They are used as a method to categorize your data. For example, the Bathymetry Contours feature class has subtypes for "Major Contours" and "Minor Contours".

Foreign key
A foreign key is a field in a relational table that matches the primary key column of another table. The foreign key can be used to cross-reference tables.

High-resolution 2D/3D Seismic Survey
Also commonly referred to as Digital Survey. The technique is identical in principle to conventional marine Seismic, except that the energy source is much smaller, and the streamer is much shorter at between 600 to 1200 metres. Typically one 2D streamer has 24 to 72 traces, 12.5m shot interval, and the record sample rate of 0.25ms to 4ms, 120 channels.

Instantiated
Instantiation is the creation of a real instance or particular realisation of an abstraction or template such as a class of objects.

Polyline ZM
A polyline ZM feature class is a polyline feature class that is able to store X, Y, Z, and M values along the linear feature. In the SSDM for example, the tracklines feature class benefits from being ZM enabled so that the tracklines can be displayed in 3D. This also allows measure values to be stored within each trackline so shot point locations can be located and symbolized.

Primary key
The primary key of a relational table uniquely identifies each record in the table. In the case of the SSDM this is the Survey_ID (long integer) or Survey_ID_Ref (text) fields which are used to uniquely identify the survey project either by a unique number or alpha-numeric method.

Shallow Geophysical Survey
Also referred to as Analogue Survey and includes the use of singlebeam/multibeam echosounder, side-scan sonar and sub-bottom profiler equipment.

Site Survey
A site survey is carried out before a well is drilled due to both a legal and operational need to have detailed seabed and shallow geophysical information around the well location for platform and drilling hazard avoidance. Also commonly referred to Analogue and Digital Site Survey where both shallow geophysical analogue system and high-resolution seismic system are deployed together.

Appendices

Please refer to the OGP Website to download links to the documents and material below:
http://info.ogp.org.uk/geomatics/

- Conceptual Data Model Diagrams
- Data Dictionary
- Sample Data Model Template
- Data Model Guidelines (FAQ, User/Contractor Guide/ArcSDE Implementation Guide)
- Sample ArcGIS Style File
- Sample Metadata File

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