# Geological Analysis and Resource Assessment of selected Hydrocarbon systems

## Deliverable 4.1

# PRELIMINARY DATA SELECTION TO PROVIDE RELEVANT INFORMATION IN ASSESSING HYDROCARBON RESOURCES IN SUBSURFACE

Authors and affiliation:
**Karen L. Anthonsen**
GEUS – Geological Survey of Denmark and Greenland

E-mail of lead author:
**kla@geus.dk**

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## GENERAL INTRODUCTION

This report **D4.1 Preliminary data selection to provide relevant information in assessing hydrocarbon resources in subsurface i.e. IP-guidelines and QA procedures** communicates the information relevant for harmonizing the produced GIS data between the GeoERA GARAH (Geological Analysis and Resource Assessment of selected Hydrocarbon systems) project and the GeoERA GIP-P (Geographic Information Platform Project) and consequently the European Geological Data Infrastructure (EGDI).

GARAH WP4 is responsible for communicating the requirements of the project to GIP-P and vice versa ensure that the guidelines and standards provided by GeoERA-IP are properly implemented in the GARAH WP2 and WP3 processes. At this stage the GARAH project all GIS data expected to be produced in the GARAH project is not fully described, but the GIS data description will follow the procedure outlined in the tables included in this report. As the GARAH project progress the tables in this report will continuously be updated.

This report summaries the information exchanged between GIP-P and GARAH projects at the GIP-P WP2 Interaction meeting 24th - 25th of October 2018 at the Royal Belgian Institute of Natural Sciences, Geological Survey of Belgium, and up to present.

## EXECUTIVE REPORT SUMMARY

This report summaries the information exchanged between the GIP-P and the GARAH projects regarding the GIS data expected to be produced in GARAH and processed by the GIP-P project for publishing at EGDI WebGIS platform.

Following vector GIS data will be produced in GARAH: Basin outlines, formation outline, play outline, exploration wells, hydrocarbon fields, faults, geothermal gradients, seafloor temperature, seafloor T heat flow, gas hydrates below seafloor, gas stability map, seismic horizon interpretations and fishing activities. Following grid GIS data will be produced: Stratigraphic surfaces, bathymetry and sedimentation rates in 4D. Each GIS data layer is described with respect to expected attributes, suggested column name and unit.

Based on the present information exchanged between GIP-P and GARAH, basic GIS data information as coordinate system, metadata, expected WebGIS functionality and searchable keywords are given.

**TABLE OF CONTENTS**

# 1 INFORMATION FROM GIP-P

The GIP-P WP8 is dedicated to provide technical support for setting up the web-services. A wiki/cookbook solution is under development at https://github.com/GeoEra-GIP

GARAH WP4 will receive a questionnaire related to IPR issues from the GIP-P WP10 and GIP-P will provide a clear timeline including the interaction processes that we have with milestones and deadlines.

The GIP-P needs to be informed if a workshop within GARAH is organized and part of it concerns data, format and attributes.

## 1.1 GIS data

GIP-P need know what kind of data GARAH will produce and their attributes to be able to provide the best standards. GIP-P is aware that asking, "What you are producing including the attributes", is an iterative process. The liaison will contact each project to setup working plan in order to clarify those questions.

## 1.2 File formats

GIP-P encourages GARAH to provide produced data via web-services. In many cases, the structure of a shape file is too limited to respect standards such as the Inspire ones.

## 1.3 3D-models

GIP-P needs more information about 3D-models such as the software used and what kind of models (2.5D layers, complex features, voxel...). GIP-P are working on a short questionnaire, which will contain data examples mapped to the common standards and precise questions about 3D data.

# 2 GIS DATA EXPECTED PRODUCED IN THE GARAH PROJECT

The GARAH Project expect to produce both vector data and grids. The expected data layers are listed below. A more detailed description of the data layers are given in chapter 3 and 4.

## 2.1 Vector data

Basin outlines (polygons)

Formation outline (polygons)

Play outline (polygons)

Exploration wells (points)

Hydrocarbon fields (polygons)

Faults (lines, will be linked to fault data produced in GeoERA 3dGEO-EU)

Geothermal gradients (?)

Seafloor temperature (points)

Seafloor T heat flow (points)

Gas hydrates below seafloor (polygons)

Gas stability map (polygons)

Horizon interpretations (lines)

Fishing activities (polygons)

### 2.2 Grids

Stratigraphic surfaces

Bathymetry

Sedimentation rates in 4D

## 3 VECTOR DATA ATTRIBUTES AND UNITS

In order to harmonize the data produced in GARAH the tables in the sub-chapters below have listed each data layer and suggestions for attribute names, column names, units and field type, supplemented with an example. Field types can be either short integer, long integer, double or text.

If possible or needed an attribute can be divided into an average value, minimum and maximum values, e.g. POR_avg, POR_min, POR_max (one column for each), this can illustrate uncertainties and range of variation.

### 3.1 Basin outline

| Attributes: Basin outline (polygons) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| Name | NAME | | Text | Wessex |

### 3.2 Formation outline

| Attributes: Formation outline (polygons) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| Name | NAME | | Text | Gassum |
| Country | COUNTRY | | Text | DK |
| Age | AGE | | Text | U. Triassic – L. Jurassic |
| Lithology | LITHOLOGY | | Text | Sandstone |
| Depth top max | DEP_TOP_MAX | Metre (m) | Numerical (Double) | -1200 |
| Depth top min | DEP_TOP_MIN | Metre (m) | Numerical (Double) | -1500 |
| Thickness | THICK_AGV | Metre (m) | Numerical (Double) | 120 |
| Volume? | VOLUME | Cubic kilo meter ($km^3$) | Numerical (Double) | |

| | | | | |
|---|---|---|---|---|
| Net/gross | NET_GROSS | ratio | Numerical (Double) | |
| Porosity | POR_AGV | % | Numerical (Double) | 20 |
| Permeability | PERMEA_AGV | milliDarcies (mD) | Numerical (Double) | 1000 |

## 3.3 Play outline

| Attributes: Play outline (polygons) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| Name | NAME | | Text | |
| Country | COUNTRY | | Text | DK |
| Age | AGE | | Text | U. Triassic - L. Jurassic |
| Lithology | LITHOLOGY | | Text | Sandstone |
| Depth top max below sea level | DEP_TOP_MAX | Metre (m) | Numerical (Double) | -1450 |
| Depth top min below sea level | DEP_TOP_MIN | Metre (m) | Numerical (Double) | -1800 |
| Thickness average | THICK_AGV | Metre (m) | Numerical (Double) | 120 |
| Volume | VOLUME | Cubic kilo meter ($km^3$) | Numerical (Double) | |
| Net/gross | NET_GROSS | ratio | Numerical (Double) | |
| Porosity | POR_AGV | % | Numerical (Double) | 20 |
| Permeability | PERMEA_AGV | milliDarcies (mD) | Numerical (Double) | 1000 |
| Salinity | SALINITY | | Numerical (Double) | |
| TOC content | TOC | % | Numerical (Double) | 3.2 |
| TOC type | TOC_TYPE | | Text | II marine |
| Thermal maturity | THERM_MAT | | Text | >0.7% Ro, oil mature |
| Mineralogy | MINERALOGY | | Text | Brittle |
| Pressure regime | PRESS_REG | | Text | Normal |
| Structural complexity | STRUC_COMP | | Text | Low to moderate |
| Hydrocarbon content | HC_TYPE | | Text | Condensate |
| | | | | |
| Play status | PLAY _STAT | | Text | Drilled |

## 3.4 Exploration wells

| Attributes: Exploration wells (points) | Column name (max. 10 characters) | Units | Field type | Example |
|---|---|---|---|---|
| Name | NAME | | Text | C1-X |
| Latitude | LAT | | Coordinate | |
| Longitude | LONG | | Coordinate | |
| x-utm | X_UTM | | Coordinate | |
| y-utm | Y_UTM | | Coordinate | |
| UTM zone | UTM_ZONE | | Text | N31 |
| Country | COUNTRY | | Text | Denmark |
| Year | YEAR | | Numerical (Short integer) | |
| Depth (below sea level) | DEPTH | Meter (m) Feet? | Numerical (Double) | 2854 |
| Hydrocarbon content* | HC_CONT | Oil, condensate, gas or mixed | Text | Oil and Gas tested |
| Operational status | OPR_STATUS | | Text | Exploration |

**Hydrocarbon content: write the primary content first*

## 3.5 Hydrocarbon fields

| Attributes: Hydrocarbon fields (polygons) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| Name | NAME | | Text | South Arne |
| Country | COUNTRY | | Text | Denmark |
| On or offshore | ON_OFFSHOR | | Text | Offshore |
| Age | AGE | | Text | U. Cretaceous - Paleogene |
| Formation | FM | | Text | Ekofisk |
| Lithology | LITHOLOGY | | Text | Chalk |
| Discovery year | DISCOV_Y | | Numerical (Double) | 1969 |
| Hydrocarbon content* | HC_CONT | Oil, condensate, gas or mixed | Text | Oil and Gas |
| Status | STATUS | Pending production, Producing, depleted, abandon | Text | Producing |
| Operator | OPERATOR | | Text | Hess |
| Operational status | OPR_STATUS | | Text | Producing |

**Hydrocarbon content: write the primary content first*

## 3.6 Faults

| Attributes: Faults (lines) | Column name (max. 10 characters) | Units | Field type | Example |
|---|---|---|---|---|
| Name | NAME | | Text | Fjerritslev |

*Remark: Faults (lines) will be linked to 3dGEO-EU project.*

## 3.7 Geothermal gradients / Heat flow

| Attributes: Geothermal gradients | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| ID name | ID | | text | 987B |
| Data source | SOURCE | | text | OceanicHeatFlow_Pollacketal1993 |
| Latitude | LAT | DD | Double | 53.7262 |
| Longitude | LONG | DD | Double | -14.389 |
| Water depth | DEPTH | Meters | Long integer signed | -1993 |
| Heat flow | HEATFLOW | mW m-2 | Double | 78.5 |
| Thermal Conductivity | T_CONDUC | W m-1 K-1 | Double | 1.24 |
| Geothermal Gradient | GEO_GRAD | mK m-1 | Double | 28.8 |
| Geothermal Gradient - 2 | GEO_GRAD2 | Celsius/ 100 m | Double | 33.1 |

## 3.8 Seafloor temperature

| Attributes: Seafloor temperature (points) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| ID name | ID | | text | 06MT18_1-A01E-558 |
| Data source | SOURCE | | text | WOCE_CTD_artic_v2 |
| Latitude | LAT | DD | Double | 53.7262 |
| Longitude | LONG | DD | Double | -14.389 |
| Water depth | DEPTH | Meters | Long integer signed | -1993 |
| Seafloor temperature | TEMP_SF | Celsius | Double | 3.3705 |
| Comments | COMMENTS | | text | Internal document |

## 3.9 Underwater masses

| Attributes: Seafloor T heat flow (polygons) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| Name | MASS_NAME | | text | MOW |
| Source | SOURCE | | text | Llave et al 2008 |
| Description | DESCRPT | | text | Mediterranean outflow water |

## 3.10 Gas hydrates direct evidences (points)

| Attributes: Gas hydrates below seafloor (points) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| ID name | ID | | text | Scg_87B |
| Cruise | CRUISE | | text | TTR-14 |
| Method | METHOD | | text | Gravity core |
| Latitude | LAT | DD | Double | 53.7262 |
| Longitude | LONG | DD | Double | -14.389 |
| Water depth | DEPTH | Meter | Long integer signed | -1993 |
| Depth below seafloor | DEPTH_BSF | Meter | Long integer signed | -0.43 |
| Data source | SOURCE | | text | Kenyon et al 2002 |
| Institution | INSTITUT | | text | GEOMAR |
| Contact name | CONTACT_N | | text | Jaco Pastorius |
| E_mail | EMAIL | | text | Pastorius.king@ip.pt |
| References | REFS | | text | 10.1029/2000GL012141 |
| Comments | COMMENTS | | text | Internal document |

## 3.11 Seismic Anomalies (polygons)

| Attributes: Gas hydrates below seafloor (polygons) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| ID name | ID | | text | Scg_87B |
| Cruise | CRUISE | | text | TTR-14 |
| Method | METHOD | | text | Gravity core |
| Area | AREA | $km^2$ | Double | 45 |
| Seismic anomaly type | ANOMAL_TYP | | text | BSR |
| Data source | SOURCE | | text | Kenyon et al 2002 |
| Institution | INSTITUT | | text | GEOMAR |
| Contact name | CONTACT_N | | text | Jaco Pastorius |
| E_mail | EMAIL | | text | Pastorius.king@ip.pt |
| References | REFS | | text | 10.1029/2000GL012141 |
| Comments | COMMENTS | | text | Internal document |

## 3.12 Seismic Anomalies (lines)

| Attributes: Gas hydrates below seafloor (lines) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| ID name | ID | | text | Line_87B |
| Cruise | CRUISE | | text | TTR-14 |
| Method | METHOD | | text | airgun |
| Data source | SOURCE | | text | Kenyon et al 2002 |
| Seismic anomaly type | ANOMAL_TYP | | text | BSR |
| Institution | INSTITUT | | text | GEOMAR |
| Contact name | CONTACT_N | | text | Jaco Pastorius |
| E-mail | EMAIL | | text | Pastorius.king@ip.pt |
| References | REFS | | text | 10.1029/2000GL012141 |
| Comments | COMMENTS | | text | Internal document |

## 3.13 Seismic Anomalies (points)

| Attributes: Gas hydrates below seafloor (points) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| ID name | ID | | text | Scg_87B |
| Cruise | CRUISE | | text | TTR-14 |
| Method | METHOD | | text | airgun |
| Latitude | LAT | DD | Double | 53.7262 |
| Longitude | LONG | DD | Double | -14.389 |
| Data source | SOURCE | | text | Jaco Pastorius |
| Seafloor depth | DEPTH_S_M | Meter | Double | 525 |
| Depth of anomaly TWT bsl | D_BSl_TWT | Second | Double | 0.5 |
| Depth of anomaly TWT bsf | D_BSF_TWT | Second | Double | 0.65 |
| Seismic anomaly type | ANOMAL_TYP | | text | Gas flare / BSR |
| Institution | INSTITUT | | text | GEOMAR |
| Contact name | CONTACT_N | | text | Jaco Pastorius |
| E-mail | EMAIL | | text | Pastorius.king@ip.pt |
| References | REFS | | text | 10.1029/2000GL012141 |
| Comments | COMMENTS | | text | Internal document |

### 3.14 Thickness of the base of the gas hydrate stability zone

| Attributes: Gas stability map (lines | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| Thickness of the Base of Gas Hydrate Stability Zone | BGHSZ | Meter | Double | 120.6 |

### 3.15 Horizon interpretations

| Attributes: Horizon interpretations (lines) | Column name (max. 10 characters) | Units | Field type GIS) | Example |
|---|---|---|---|---|
| ID | | | Text | |
| Name | | | Text | |

### 3.16 Fishing activities

| Attributes: Fishing activities (polygons) | Column name (max. 10 characters) | Units | Field type (GIS) | Example |
|---|---|---|---|---|
| Name | NAME | | Text | Doggerbanke |
| Activity type | TYPE | | Text | Hooks |

## 4 GRID DATA

Tree thematic layers have been identified: Stratigraphic surface, bathymetry and sedimentation rates in 3D.

### 4.1 Stratigraphic surfaces

Stratigraphic surfaces with grid cells values as meters below sea level. The stratigraphic surfaces (horizons) expected to be included in GARAH are shown with red in figure 1.

### 4.2 Bathymetry

Bathymetry with grid cells values as meters below sea level.

### 4.3 Sedimentation rates in 4D

At present it's not clear how this data will be presents as grid data.

### 4.4 Thickness of the base of the gas hydrate stability zone

At present it's not clear how this data will be presented as grid data.

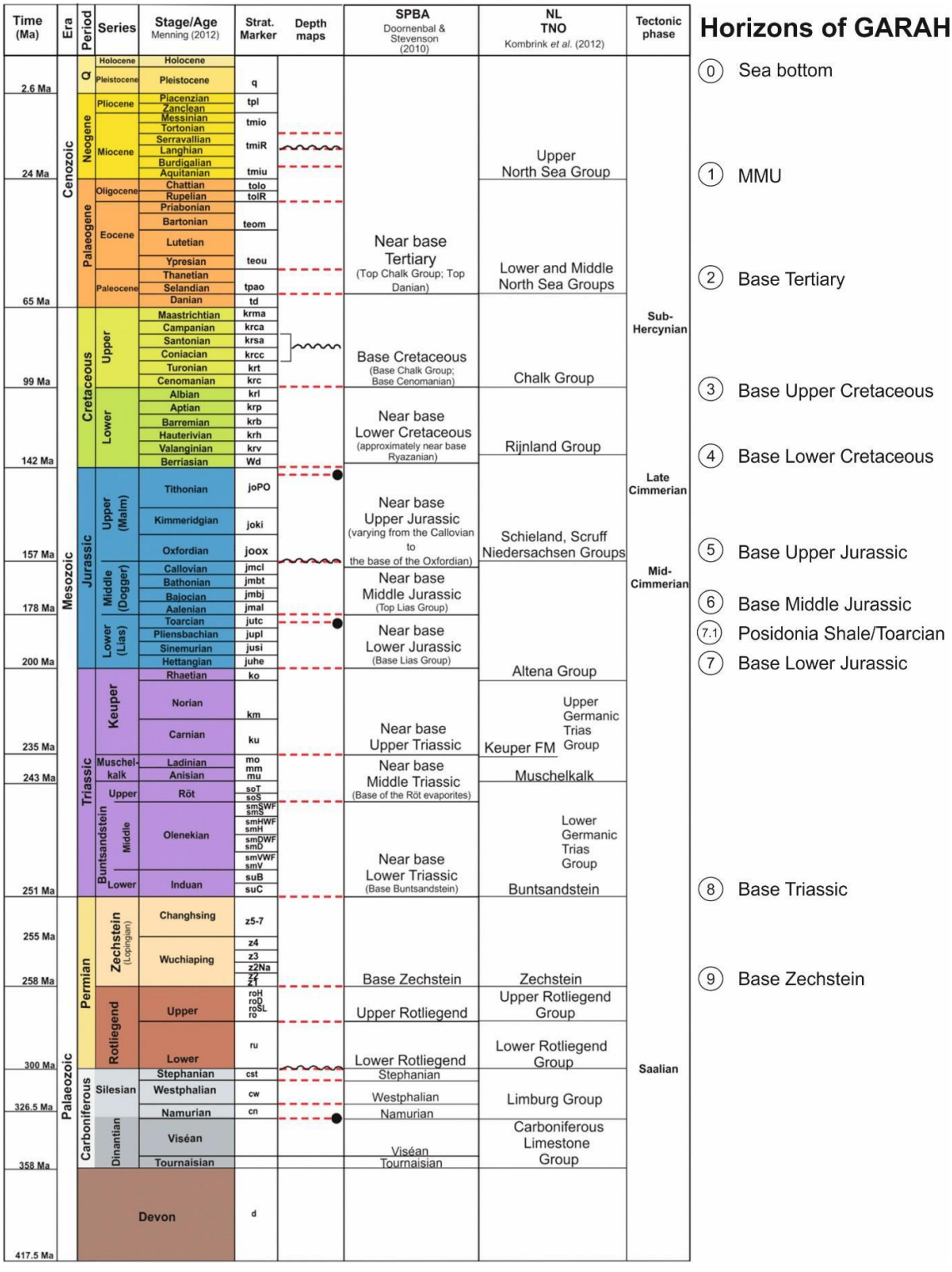


Figure 1. Provisional, non-harmonized nomination of model horizons (Subsequent, possible integration of further Jurassic to Tertiary horizons)

## 5 GEOGRAPHIC PROJECTIONS

It is recommend to use the projections listed by Inspire. At present, the WebGIS portals support two projections, WGS 84 and ETRS 89 LCC. GIP-P consider adding ETRS 89 LAEA (Lambert Azimuthal Equal Area) to the system for true area representation purposes.

## 6 METADATA

Metadata is literally "data about data". It is a description of the content, quality, lineage, contact, condition, and other characteristics of data. Pertaining to spatial data, metadata can help provide answers to such questions as:

- Who created the data?
- When was the data created?
- When was the data updated?
- Why was the data created / what does it represent?
- What kind of data is it?
- How accurate is the data?

Metadata is a critical and mandatory component of a dataset and should comply with the ISO standards. Metadata preserve the usefulness of all types of environmental data over time by detailing methods for data collection and dataset creation.

The ISO metadata standard must be: ISO 19115-1:2014 for Geographic Information Metadata

Further details and information about metadata will be described in a follow-up notice.

## 7 WEBGIS FUNCTIONALITY

The GIP-P has requested information on how the GARAH project expect users to work with the data in the WebGIS platform. At present one functionality has been communicated to GIP-P and that is the option for users to make queries (Query builder).

## 8 KEYWORDS TO SEARCH CATEGORIES

WP4 have submitted the keywords listed in the table below to GIP-P 9/11-2018. The list can be extended.

| Terms extracted | Search Categories |
|---|---|
| 3D models: geological, deep, fault plane surfaces, structural-geological model, petroleum system, seismic interpretation, t, Fracture, facies | GEOTHERMAL RESOURCES |
| | GEOLOGICAL PROCESSES |
| | STRUCTURAL GEOLOGY |

| | |
|---|---|
| | APPLIED GEOPHYSICS |
| | FOSSIL RESOURCES |
| | LITHOLOGY |
| Assessment of the conventional and unconventional resources | GEOLOGICAL PROCESSES |
| | APPLIED GEOPHYSICS |
| | LITHOLOGY |
| | GEOCHEMISTRY |
| Gas Hydrate | APPLIED GEOPHYSICS |
| | FOSSIL RESOURCES |
| | GEOCHEMISTRY |
| Geological storage of CO2 | GEOLOGICAL PROCESSES |
| | STRUCTURAL GEOLOGY |
| | APPLIED GEOPHYSICS |
| GIS layers | INFORMATION SYSTEM |
| | FOSSIL RESOURCES |
| Hazards: geological hazards | GEOLOGICAL PROCESSES |
| | LITHOLOGY |
| | NATURAL HAZARD |
| HC resources | GEOLOGICAL PROCESSES |
| | APPLIED GEOPHYSICS |
| | FOSSIL RESOURCES |
| | LITHOLOGY |
| | GEOCHEMISTRY |
| GIIP: Gas Initially in place | GEOLOGICAL PROCESSES |
| | APPLIED GEOPHYSICS |
| | FOSSIL RESOURCES |
| OIIP: Oil Initially in place | GEOLOGICAL PROCESSES |
| | APPLIED GEOPHYSICS |
| | FOSSIL RESOURCES |

| | |
|---|---|
| Reservoir rock parameters | APPLIED GEOPHYSICS |
| | PETROPHYSICS |
| | LITHOLOGY |
| | FOSSIL RESOURCES |
| Shale formations | GEOCHRONOLOGY |
| | CHRONOSTRATIGRAPHY |
| | GEOLOGICAL PROCESSES |
| | INFORMATION SYSTEM |
| Source rocks | GEOLOGICAL PROCESSES |
| | APPLIED GEOPHYSICS |
| | LITHOLOGY |
| | GEOCHEMISTRY |
| Tectonostratigraphic models; geochemical and geological | STRUCTURAL GEOLOGY |
| | MODELLING |
| Geological 3D models | MODELLING |
| Unconventionals | FOSSIL RESOURCES |
| Conventionals | FOSSIL RESOURCES |