



## Geological Analysis and Resource Assessment of selected Hydrocarbon systems

### Deliverable

### GARAH.D.3.1: Available hydrate related data in the European Continental Margins

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## GENERAL INTRODUCTION

The aim of the Geological Analysis and Resource Assessment of selected Hydrocarbon systems (GARA) is to develop a harmonized, scientific based, geological analysis and assessment conventional and unconventional hydrocarbon resources that will help member states to continue the transition to lower Carbon energy sources. This will contribute to climate commitments, and allow the planning for secure sources of affordable energy. The analysis and assessment of hydrocarbons will focus on two areas:

(i) in Europe's major petroleum province – the North Sea and include a “Geological analysis and resource assessment of North Sea petroleum systems”, This research includes the assessment of conventional and unconventional oil and gas resources in the most important hydrocarbon basin in Europe. This will enable the remaining resource to be better understood and managed, and identify options for multiple and alternative uses of the subsurface as producing fields come off-line.

(ii) with a pan-European view, “Hydrate assessment in the European continental margin and related risks”.

The assessment of gas-hydrates resources in the European continental margin represents an information gap of pan-European interest. This will improve the understanding of the potential role that gas-hydrates may play in the future EU energy mix, as it will constitute a base-line for future projects pertaining the improvement of the European model of the GHSZ, related hazards and potential for geological storage of CO<sub>2</sub>.

A catalogue evaluating the multiple-use of hydrocarbon reservoirs, as integrated or alternative use of the subsurface, together with an appraisal on risks and safety, will be produced.



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## 1 OBJECTIVE

This report describes the collection of hydrate related data and information that will be incorporated in the GARAH project GIS-database under work package 3 (WP3). Also included is a listing of data specifics with location, source, accessibility/use, size, and data type.

## 2 SCOPE AND FRAMEWORK

The data collection area has a pan-European scope. The geographical study area involves covers a wide view part of the European margins (Fig. 1) from Macaronesia (SW corner: 24° 15'N; 36° 10'W), to the Black Sea, and Barents Sea (NE corner: 60° 40'E, 90°N).

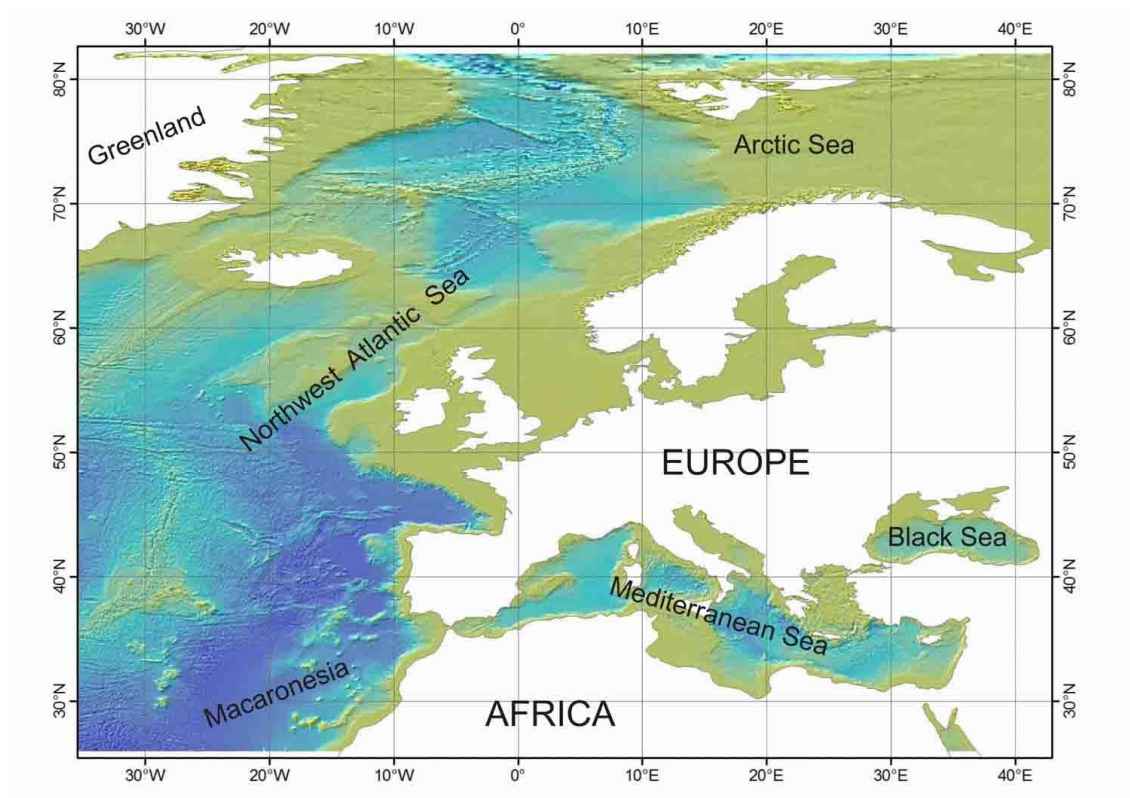


Figure 1.- Study area of the GARAH WP3

Regarding the thematic layers, data Data collection covers all available, (free and public) information gas- hydrate- related information, and are organized in thematic layers such as direct evidences (samples), gas compositions, seafloor temperatures, heat flow or and seismic gas- related anomalies, as described below.



## **2.1 Seafloor temperature**

Gas hydrates require low temperatures to become stabilized on and near the seabed. Hence, information on bottom water temperature is critical to map the potential distribution of gas hydrates. Water temperature information from a number of sources are gathered in this study to provide seabed temperature and temperature gradients in order to identify areas of gas hydrate preservation.

## **2.2 Geothermal gradient**

Geothermal gradient in the subsurface is also important in order to understand the generation of gas at depth and potential preservation of gas hydrates, as a high heat flow will generally preclude the existence of hydrates. Information on subsurface temperatures from wells, boreholes, and models are collated to provide such information.

## **2.3 Geological maps**

The formation and preservation of gas hydrates require specific geological conditions. Maps of the surficial seabed geology are useful in this context, e.g., information on seabed sediments can be used to constrain the potential location of gas hydrates, while the presence of non-permeable bedrock at seabed generally precludes the formation and preservation of gas hydrates.

Similarly, information regarding the nature and distribution of geomorphological features can be used to predict the presence and stability of gas hydrates. Thus, mapped landforms indicative of fluid flow, such as pockmarks and mud volcanoes, are also captured by the project.

## **2.4 Bathymetry**

Gas hydrate formation and stabilisation requires high pressures and low temperatures. Depending on water temperatures, hydrates may occur at water depths as shallow as 150 meters, however, water depths greater than around 300 meters are considered to be more likely for hydrate formation within the WP3 study area. Detailed bathymetric information is used to identify the areas with suitable water depths for the formation and preservation of gas hydrates.

## **2.5 Seismic anomalies**

The presence of gas hydrates may be observed on reflection seismic data by the presence of cross-cutting seismic reflectors known as Bottom Stimulating Reflectors (BSRs), where the change in acoustic impedance may indicate the lower limit of the hydrate stability zone. The location of seismic lines with known BSRs or in areas of suitable depths/temperatures for the formation and preservation are collated in this study.

## **2.6 Reports and papers**

A number of figures and papers related to gas hydrate occurrences within the WP3 study area have been collected. These are taken from published papers and reports and includes; seabed geology, depth to hydrate stability zones, areas of seabed features indicative of fluid flow, water column composition and temperature, location of biogenic carbonates,



landforms and seabed sediments. Figures are presently stored in jpeg or pdf file format, but will be georeferenced if found to be useful.

### **3 INVENTORY OF DATA COLLECTION**

A total of 835 records (10.75 Gb) have been collected as part of task 3A. These contain information about the oceanographic variables (seafloor temperatures, heat-flow), hydrate direct samples, geological information and seismic anomalies. The inventory of the collected data has been structured based on the data source. Details are provided in [Annex 1](#). There are two main groups of data: (i) data of pan-European origin coming from public and free databases derived from EU projects such as EMODnet, PERGAMON and MIGRATE; and (ii) data of regional scope coming from scientific organizations.

#### **3.1 PERGAMON**

This database was developed by the geological surveys of Spain and Ireland during 2011 and 2012 with a Short Term Scientific Mission (STSM ES0902-250312-016293) in the PERGAMON was a COST action (ES0902).

The geospatial data were organized into a series of themes. Theme datasets are: Cultural Data, Bathymetry, Geothermal Gradient, Oceanography and Geology. The Cultural Data theme stores all information related to coastlines, boundaries of countries and limits of the study area. The Bathymetry Data theme stores vector (iso-bathymetry lines) and raster (DTM) datasets. The Geology Data theme stores information related to the borehole location of the IODP Project and theoretical thickness of the Gas Hydrate Stability Zone (GHSZ) in the Arctic Sea. The Geothermal Gradient Data theme stores geothermal gradient information from to heat flow probe and borehole data. The Temperature Data theme stores oceanographic information from the World Ocean Atlas (WOA09).

#### **3.2 MIGRATE**

This database was developed by Work Package 1 of the MIGRATE COST action (ES1405) project, led by the University of Southampton and the National Oceanographic Centre (NOC). 21 organizations from 15 countries are involved (Minshull et al. 2019).

The MIGRATE database stores information regarding direct and indirect evidence of gas hydrates. Data regarding direct evidence of gas hydrates is from samples described in publications. Indirect information includes: seismic indicators such as BSR levels and areas, gas chimneys, high reflectivity areas, velocity anomalies. Other gas hydrate information includes: seabed features (gas seepages areas); heat flow data; sediment thickness models; pore water anomalies; theoretical models of the base of the Gas Hydrate Stability Zone; and relief and bathymetry models.

The MIGRATE information contains 1892 records including vector and raster data.

#### **3.3 EMODnet Geology**

Information from the EMODnet Geology portal (queried 1<sup>st</sup> of January 2019) includes a shapefile with hydrate evidences in the Gulf of Cádiz, Barents Sea and Black Sea to a total of 28 records.



### **3.4 IGME**

The *Instituto Geológico y Minero de España* has collected information related to oceanographic variables such as seafloor temperature and heat flow/geothermal gradient, as well as direct sampling data, internal reports and several local theoretical models of the base of the GHSZ.

### **3.5 BGS**

The *British Geological Survey* has collected: CDT/STD Cast information from the British Oceanographic Data Centre (<https://www.bodc.ac.uk/>); gas hydrate-related information from BGS reports and PhD thesis; the location of seismic profiles from the BGS online portal; the distribution of seabed pockmarks; and several local theoretical models of the base of the GHSZ.

### **3.6 BRGM**

The *Bureau de Recherches Géologiques et Minières* has collected: heat flow and thermal conductivity information in the Biscay Bay and Celtic Sea as well as several local models of sediment thickness, the depth of the CO<sub>2</sub> and CH<sub>4</sub> hydrate stability zone, and the depth of the base of the negative buoyancy zone.

### **3.7 GIU**

The State Research and Development Enterprise *GeoInform of Ukraine* (GIU) has collected an inventory map with evidence for gas hydrates in the Crimean peninsula of the Black Sea.





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#### **4 ANNEX 1**

Please refer to the attached file and chapter 3 in this report.