

A pan-European GIS focused on gas hydrates: a research base-line in geohazards and geological storage of CO₂

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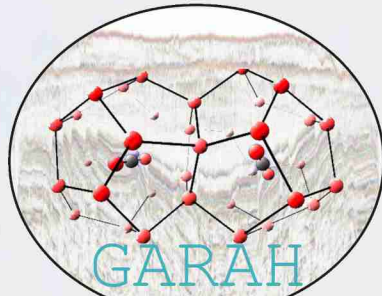
Gas-hydrates have been studied as potential drivers of global climate change, and in relation to geo-hazard assessment or derived heat-flow. The main variables controlling the gas-hydrate stability zone (GHSZ) are: gas-composition; geothermal gradient; pressure (bathymetry); and seafloor temperature. Two regions (Antarctica and western European margins) were selected for calculation of the theoretical base of the GHSZ based on free and publically available data stored as part of the international GARAH project database (Geological Analysis and Resource Assessment of selected Hydrocarbon systems).

The results of calculations for both regions demonstrate that the density and reliability of these free and public data are valid only for larger studies. In areas where the seafloor temperature is well known, such as the Mediterranean Sea and the Gulf of Cádiz, the presence of geomorphological features such as pockmarks and submarine landslide structures correlate well with the location of the theoretical base of the GHSZ. However, in other areas with a low density of data (Antarctica, and west Galician and Bay of Biscay margins), it has not been possible to produce a precise model of geothermal gradient, nor has it been possible to account for the influence of bottom water currents in controlling seafloor temperatures. In these cases, the uncertainty is larger, and it has not been possible to achieve a clear correlation between the base of GHSZ and the geological and geophysical features (Bottom Simulating Reflectors, pagoda-structures, pockmarks or submarine landslides).

The lack of a precise and available (free access) dataset of detailed information about geological and oceanographic variables limits our knowledge about continental margins, and hence key factors controlling the position of the base of GHSZ. This in turn prevents accurate assessments linked to climate models and assessment of natural risks. The GARAH project aims to address these gaps in knowledge, and build the pan-European gas-hydrate data infrastructure necessary to allow assessment of the European continental margin. This includes objectives to: 1) Develop a harmonized database of European gas-hydrate data; 2) Identify specific areas of interest or having critical knowledge gaps which would benefit from further research; 3) Provide recommendations on how future data should be collected and stored to be fully interoperable. These objectives will provide critical information for assessments relating to geohazards and risks (eg. seismicity), assessments of the abundance of sediment-hosted gas-hydrates, and evaluations of the role that CO₂-rich hydrates might play during the geological storage of CO₂. GARAH will thus play a crucial role in advancing our knowledge about, and modelling of, gas-hydrate stability along European margins.

Acknowledgment

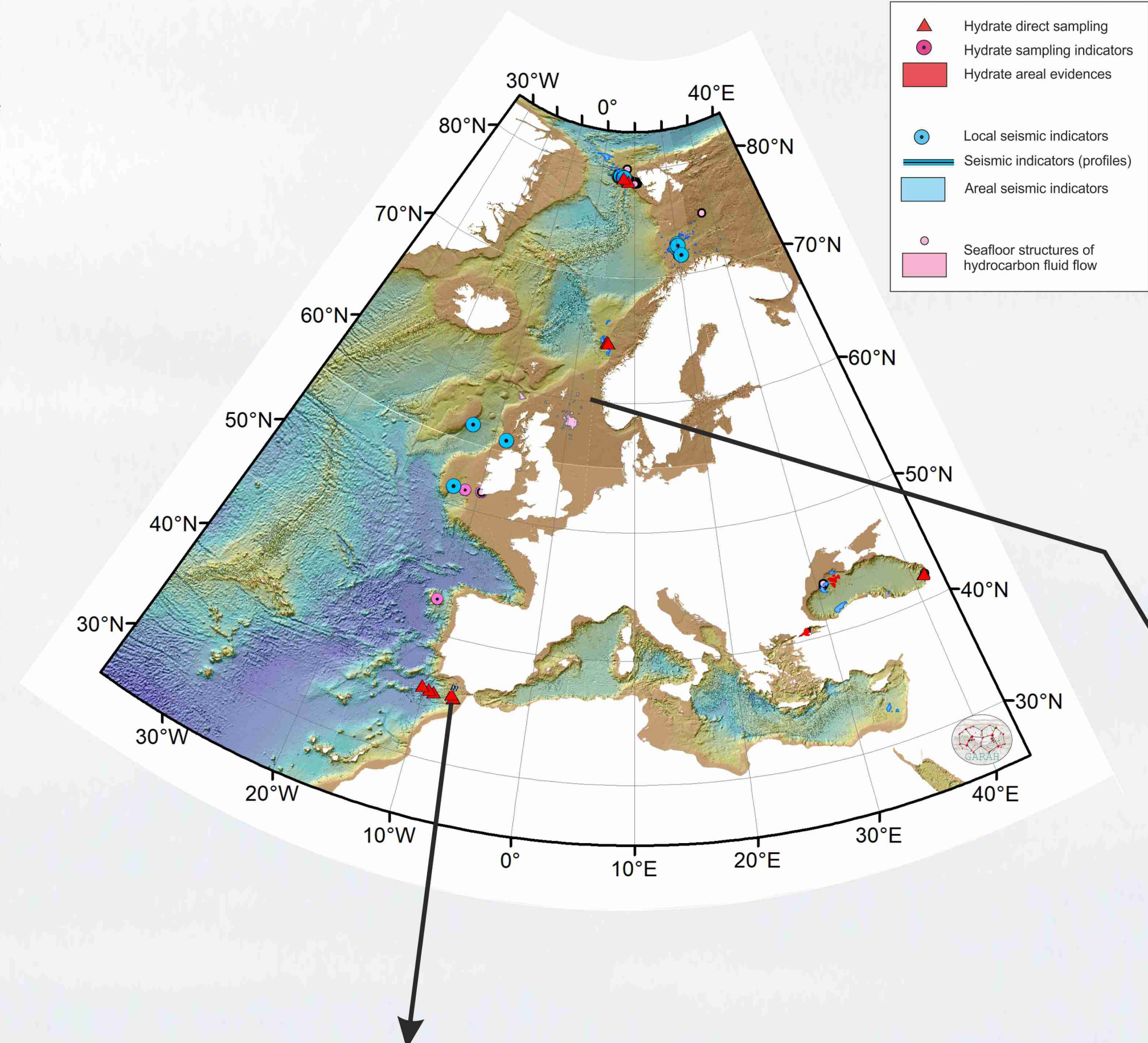
GARAH project. GeoERA - GeoE.171.002



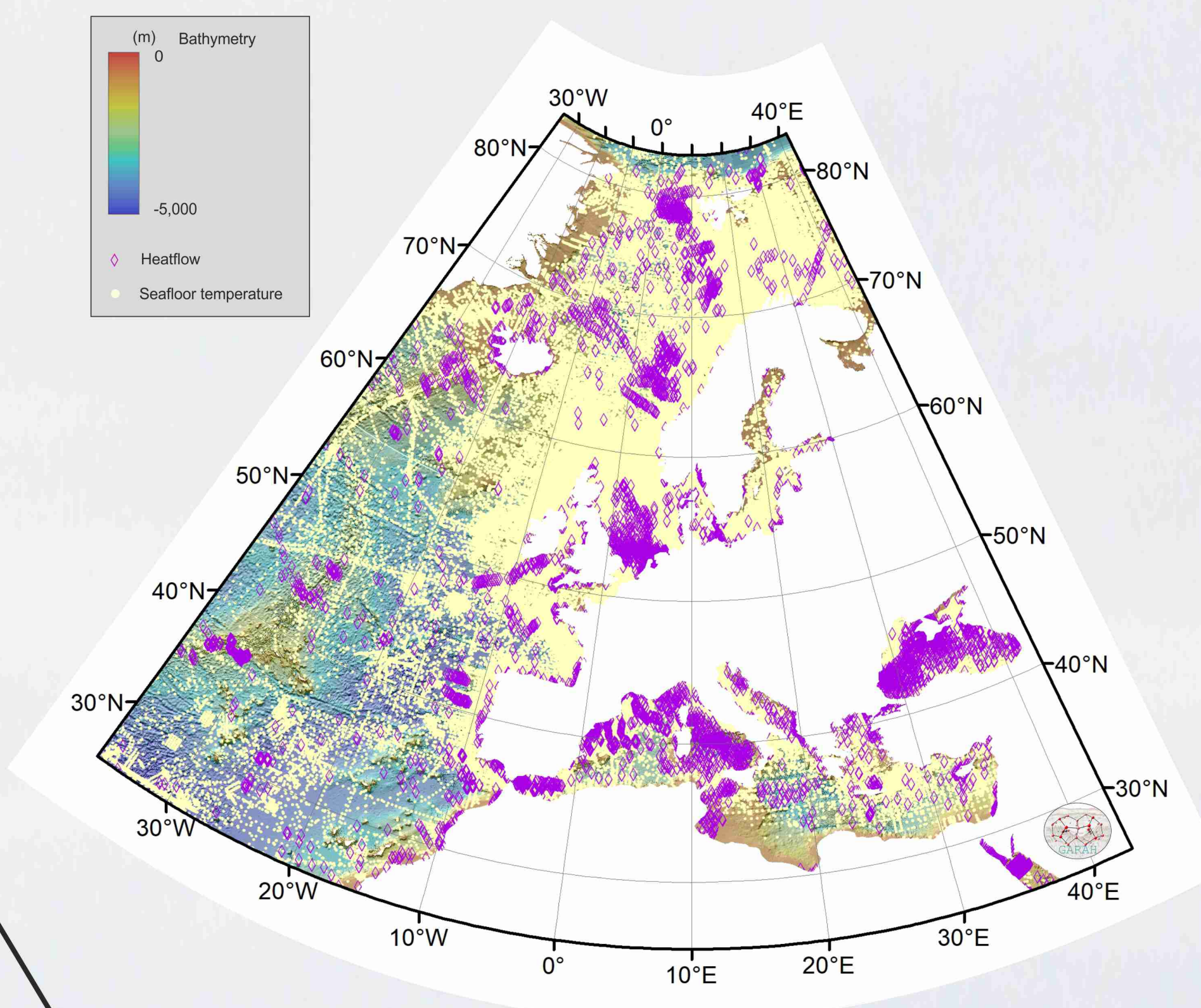
References:

Divins, D. L. (2003). Total Sediment Thickness of the World's Oceans and Marginal Seas. (<https://www.ngdc.noaa.gov/mgs/sedthick/sedthick.html>).
León, R., Somoza, L., Giménez-Moreno, C.J., Dabrio, C.J., Errilla, G., Prang, D., Díaz-del-Río, V., Gómez-Delgado, M. (2009). A predictive numerical model for potential mapping of the gas hydrate stability zone in the Gulf of Cádiz. Marine and Petroleum Geology, 26(8), 1564-1579
Piñero, E., Marquardt, M., Hensen, C., Haackel, M., & Wallmann, K. (2013). Estimation of the global inventory of methane hydrates in marine sediments using transfer functions. Biogeosciences, 10(2), 959.

Geological / Geophysical evidences and indicators



Oceanographic variables



Hydrates Evidences & Indicators			
GasHydrate_Site_Evidences&Indicators -- Points			
FILENAME	FORMAT	DESCRIPTION	
U_Name	Text, 254	Identification code of the evidence - PK	
Lat_ID	Double, 15.8	Latitude in decimal degrees (WGS84)	
Long_ID	Double, 15.8	Longitude in decimal degrees (WGS84)	
WaterDepth	Double, 15.8	Seafloor depth	
Geosetting	Text, 50	Geographical / Geological Setting - Constraints/NL, LV	
Location	Text, 50	Local where the evidence is located	
Data_Source	Text, 254	Institution/Company / Owner of Data, Project, database or publication where data have been collected	
Cruise	Text, 254	Oceanographic Cruise where data have been recovered or observed	
Owner	Text, 50	Contact name	
Email	Text, 50	Contact Email	
FT_Type	Text, 50	Type of evidence - constrain: NL, LV, FT_Type	
Description	Text, 250	Description of the evidence - Free text	
Depth_top	Text, 50	Depth of the top of the evidence below seabed in meters	
Depth_bot	Text, 50	Depth of the bottom of the evidence below seabed in meters	
Depth_top_TWTT	Text, 50	Depth of the top of the evidence below seabed in seconds TWTT	
Depth_bot_TWTT	Text, 50	Depth of the bottom of the evidence below seabed in seconds TWTT	
DOI	Text, 254	DOI of main data publication	
References	Text, 254	Referenced data, Author, Year & Title Link to PDF in data repository	
Comments	Text, 254	Comments - Free text	

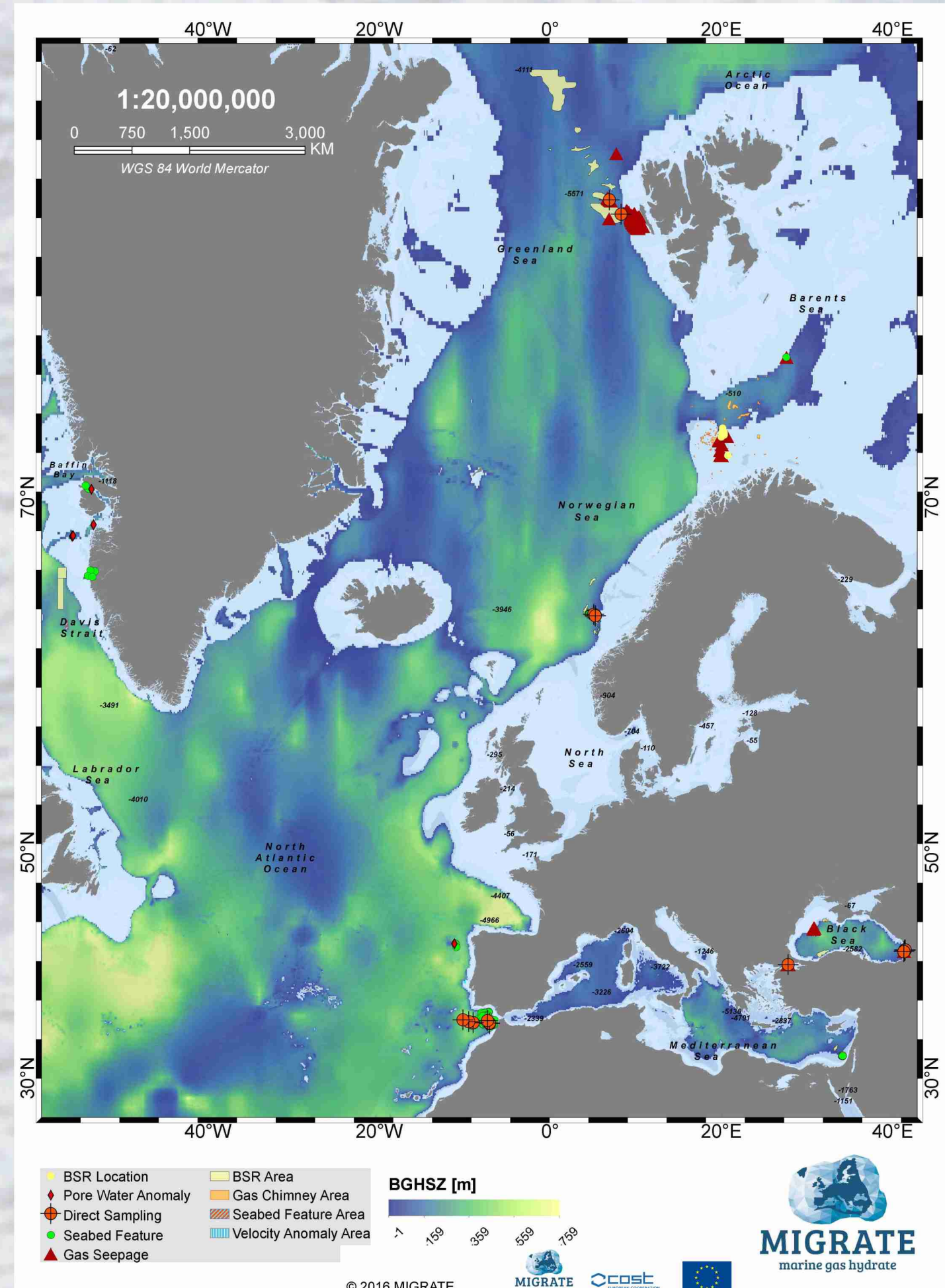
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Depth_top_TWTT	Text, 50	Depth of the top of the evidence below seabed in seconds TWTT	
Depth_bot_TWTT	Text, 50	Depth of the bottom of the evidence below seabed in seconds TWTT	
DOI	Text, 254	DOI of main data publication	
References	Text, 254	Referenced data, Author, Year & Title Link to PDF in data repository	
Comments	Text, 254	Comments - Free text	

Seabed fluid flow Indicators			
FILENAME	FORMAT	DESCRIPTION	
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Long_ID	Double, 15.8	Longitude in decimal degrees (WGS84)	
WaterDepth	Double, 15.8	Seafloor depth	
Geosetting	Text, 50	Geographical / Geological Setting - Constraints/NL, LV	
Location	Text, 50	Local where the evidence is located	
Data_Source	Text, 254	Institution/Company / Owner of Data, Project, database or publication where data have been collected	
Cruise	Text, 254	Oceanographic Cruise where data have been recovered or observed	
Owner	Text, 50	Contact name	
Email	Text, 50	Contact Email	
FT_Type	Text, 50	Type of evidence - constrain: NL, LV, FT_Type	
Description	Text, 250	Description of the evidence - Free text	
Depth_top	Text, 50	Depth of the top of the evidence below seabed in meters	
Depth_bot	Text, 50	Depth of the bottom of the evidence below seabed in meters	
Depth_top_TWTT	Text, 50	Depth of the top of the evidence below seabed in seconds TWTT	
Depth_bot_TWTT	Text, 50	Depth of the bottom of the evidence below seabed in seconds TWTT	
DOI	Text, 254	DOI of main data publication	
References	Text, 254	Referenced data, Author, Year & Title Link to PDF in data repository	
Comments	Text, 254	Comments - Free text	

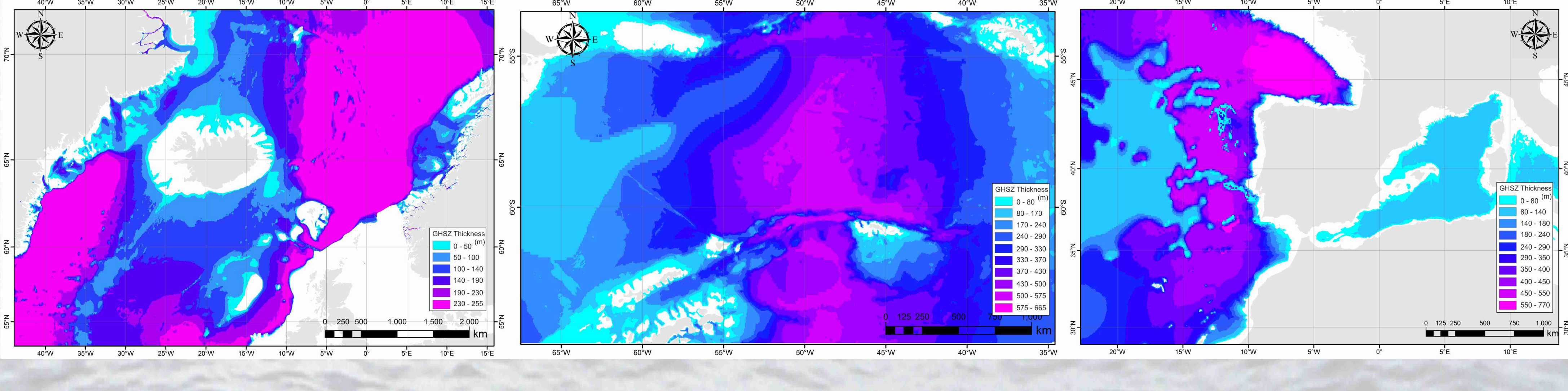
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Long_ID	Double, 15.8	Longitude in decimal degrees (WGS84)	
WaterDepth	Double, 15.8	Seafloor depth	
Geosetting	Text, 50	Geographical / Geological Setting - Constraints/NL, LV	
Location	Text, 50	Local where the evidence is located	
Data_Source	Text, 254	Institution/Company / Owner of Data, Project, database or publication where data have been collected	
Cruise	Text, 254	Oceanographic Cruise where data have been recovered or observed	
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Email	Text, 50	Contact Email	
FT_Type	Text, 50	Type of evidence - constrain: NL, LV, FT_Type	
Description	Text, 250	Description of the evidence - Free text	
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Depth_bot_TWTT	Text, 50	Depth of the bottom of the evidence below seabed in seconds TWTT	
DOI	Text, 254	DOI of main data publication	
References	Text, 254	Referenced data, Author, Year & Title Link to PDF in data repository	
Comments	Text, 254	Comments - Free text	

Oceanographic variables

OCEANOGRAPHIC VARIABLES / GEOLOGICAL CONSTRAINTS			
FILENAME	FORMAT	DESCRIPTION	
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Long_ID	Double, 15.8	Longitude in decimal degrees (WGS84)	
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Measure_Depth	Double, 15.8	Water depth of the temperature measured (m)	
Temp	Double, 15.8	Temperature (°C)	
Data_Source	Text, 254	Institution/Company / Owner of Data, Project, database or publication where data have been collected	



Map of hydrate evidences developed as part of COST-MIGRATE Project "Marine gas hydrate – an indigenous resources of natural gas for Europe" (<https://www.migrate-cost.eu>). Theoretical thickness of gas-hydrate stability zone (GHSZ) for pure methane taken from Piñero et al. (2003).



Theoretical thickness (in meters) of the gas-hydrate stability zone (GHSZ) for pure methane in three areas (Arctic, Antarctic and western Europe) applying the method of León et al. (2009) with the constrain of the sedimentary thickness of deep basins (sediment thickness taken from Divins 2003).



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IGME, GEUS, BRGM, NERC – BGS,
GEOINFORM

Ricardo León





A pan-European GIS focused on gas hydrates: a research base-line in geohazards and geological storage of CO₂

GARAH project (GeoERA - GeoE.171.002)

WP-3

Hydrate assessment in the European continental margin and related risks

To develop a harmonized model for a pan-European gas hydrate data infrastructure. A GIS-database will be developed that includes key gas hydrate observations (both direct and indirect), relevant oceanographic variables (seafloor temperature, heat flow, bathymetry, sedimentation rates, etc.) and modelled hydrate stability thickness.

It will identify the critical knowledge gaps and provide information on areas of interest for future joint projects. It will also provide recommendations on how future data should be collected and stored to be fully interoperable. It will thus lay the groundwork for future projects related to improving models of the gas hydrate stability zone (GHSZ) along European margins. This is essential for assessments relating to geohazards and risks, assessments of the abundance of sediment-hosted gas hydrates, and evaluations of the role of CO₂-rich hydrates for the geological storage of CO₂.



A pan-European GIS focused on gas hydrates: a research base-line in geohazards and geological storage of CO₂

Task 3A - Collection of data sources to be implemented in the hydrate related GIS-database

Task 3B - Definition of the data model structure and data loading.

Task 3C - Integration of results.

3A. Collection of data sources to be implemented in the hydrate related GIS-database

REPORT D3.1 of GARAH Project

835 information layers of information (10.75 Gb)

- data of pan-European scope coming from public and free databases such as EMODnet, PERGAMON or MIGRATE
- data of regional scope coming from scientific organizations

Name	Description	Source	Importance	Format of data	Size (Mb)	Georeferenced	metadata available	Meta-Standardised	Quality	GA
Marine_Gas_Hydrate_Deposits	Polygon SHP - EMODnet Geology	EMODnet Geology	high	Shapefile	0.248	yes	yes	yes	high	
Metadata_EMODnet_Geology_WP7_Minerals.pdf	Description of the Metadata from EMODnet	EMODnet Geology	high	PDF	0.244	no				
					1.077					
Gebco_Arctic_xyz.rar	Data source	Gebco Atlas 2003	high	RAR		no	yes	no	high	
IBCAO_Ver3_BR_2012-03-16.tif	Data source	IBCAO 2008	high	tiff		yes	yes	yes	high	
gebco_bathy	Digital bathymetry model	Gebco Atlas 2003	high	raster		yes	yes	yes	high	
gebco_shade	Hillshade model	Gebco_bathy	high	raster		yes	yes	yes	high	
ibcao_bathy	Digital bathymetry model	IBCAO 2008	high	raster		yes	yes	yes	high	
ibcao_shade	Hillshade model	ibcao_bathy	high	raster		yes	yes	yes	high	
					7.8					
Countries_Lines	Line SHP - hillshade	ESRI	low	shapefile		yes	yes	yes	high	
Study_Area	Polygon SHP of the AOI	PERGAMON	low	shapefile		yes	yes	yes	high	
					0.878					
gscof_5816_e_2008_mn01.pdf	Geological map of the Arctic	Geological Survey of Canada, 2008	low	PDF		no	yes	no	high	
gscof_5816_e_2008_mn02.pdf	Legend of the Geological map of the Arctic	Geological Survey of Canada, 2008	low	PDF		no	yes	no	high	
gscof_5816_e_2008_mn03.pdf	Lithologies of the Geological map of the Arctic (part 1)	Geological Survey of Canada, 2008	low	PDF		no	yes	no	high	
gscof_5816_e_2008_mn04.pdf	Lithologies of the Geological map of the Arctic (part 2)	Geological Survey of Canada, 2008	low	PDF		no	yes	no	high	
gscof_5816_e_2008_mn05.pdf	Lithologies of the Geological map of the Arctic (part 3)	Geological Survey of Canada, 2008	low	PDF		no	yes	no	high	
AAG_2003_icelandhf.pdf	Article about Mantle plumes	AAG, 2003	low	PDF		no	yes	no	high	
Hustof_etal_2009_Svalbard.pdf	Gas hydrate reservoir (from Strait - NW Svalbard)	Earth and Planetary Science Letters 284 (12-24)	low	PDF		no	yes	no	high	
Jakobsson_etal_2008_IBCAO_GRL_2008.pdf	Bathymetry of Arctic Ocean (IBCAO)	Geophysical Research Letters, vol. 35 L07602	low	PDF		no	yes	no	high	
Mienert_etal_2005.pdf	Gas hydrate stability (Storegga Slide, Norway)	Marine and Petroleum Geology 22 (233-244)	low	PDF		no	yes	no	high	
Petersen_etal_2010.pdf	3D seismic imaging of gas chimney (Arctic sediment drift)	Marine and Petroleum Geology 27(9) 1981-1994	low	PDF		no	yes	no	high	
Rajan_etal_2012_Svalbard.pdf	Gas migration in NW-Svalbard	Marine and Petroleum Geology 32 (36-49)	low	PDF		no	yes	no	high	
Vannest_etal_2005_et.pdf	Geothermal gradients in W Svalbard margin	Terra Nova vol. 17 (6), 510-516	low	PDF		no	yes	no	high	
Wessel_&_Smith_1998.pdf	Global inventory of Natural Gas Hydrate Occurrence	USGS, 1998	low	PDF		no	yes	no	high	
dsdpites.sbx	Point SHP - DSDP sites location	IODP	high	shapefile		yes	yes	yes	high	
odpsites.sbx	Point SHP - ODP sites location	IODP	high	shapefile		yes	yes	yes	high	

GARAHydrates – Data Model Structure

GEOLOGICAL & GEOCHEMICAL EVIDENCES-INDICATORS

GEOPHYSICAL INDICATORS

Gas hydrate Area/Geophy. indicators: Poik.

[illegible][illegible][illegible]

GEOGRAPHIC INFORMATION SYSTEM DIRECTORY STRUCTURE

[illegible][illegible]

Sediments Thickness: 800m

FILE NAME	FORMAT	DESCRIPTION
1 Longitude	Ascii (Double) (H, E)	Longitude coordinates in decimal degrees (0-35.5 to 5.535)
1 Latitude	Ascii (Double) (H, E)	Latitude coordinates in decimal degrees (0-35.5 to 5.535)
1 X ₁₀₀ km	Ascii (Double) (H, E)	Value of the coordinate this line is, in meters

GMS2: Base

Parameter	Format	Description
λ longitude	float (double) [0,0]	λ longitude coordinates in decimal degrees [0°N to 360°E]
ϕ latitude	float (double) [-90,0]	latitude coordinates in decimal degrees [0°N to 90°S]
r_{min} r = 0	float (double) [0,0]	Value of the <i>r</i> coordinate: radius [0, 100000, etc.] in meters

[illegible]

Cellulose Profile Graphs Indicators: Line

χ^2_{pooled}	Year: 1981	Identification code of the evidence: 90
Age range	Indice: 1981	Cartographic scale of the map of the indicator
	Indice: 1981	
Location	Year: 1981	Geographical / Ecological context: Evidence title: 90
Available	Year: 1981	Used to address the evidence is located
Access	Year: 1981	Access: Geographical / Context of data: Project, database or publication where data have been
Index	Year: 1981	Geographical Index where the evidence has been presented or abstracted
Access	Year: 1981	Access: Geographical / Context of data: Project, database or publication where data have been
Index	Year: 1981	Contact Person
IP-2000	Year: 1981	Type of evidence: Evidence title: 90/90-IP-2000
Index	Year: 1981	Description of the evidence: Use title
$\chi^2_{\text{total_value}}$	Indice: 1981	Depth of the top of the evidence before studied to studies
$\chi^2_{\text{total_value}}$	Indice: 1981	Depth of the bottom of the evidence before studied to studies
$\chi^2_{\text{total_value}}$	Indice: 1981	Depth of the top of the evidence before studied to studies: 90/90
$\chi^2_{\text{total_value}}$	Indice: 1981	Depth of the bottom of the evidence before studied to studies: 90/90
DOI	Year: 1981	DOI of main data publication
References	Year: 1981	References to data abstract: Year 81: 1981 to 1981 in PDF in data repository
Comments	Year: 1981	Comments: Data title
Year: 2000	Year: 1981	Year: 2000: Year: 1981
Year: 2000	Year: 1981	Year: 2000: Year: 1981

OCEANOGRAPHIC VARIABLES & GEOLOGICAL CONSTRAINTS

MeanFlow: Global Points

[illegible]

Seafloor Temperature: Points

YRI variable	YRI label	ENCORE description
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<i>Long_Deg</i>	Double	Longitude in decimal degrees (0-2.100)
<i>Lat_DegD</i>	Double	Latitude degree
<i>Long_DegD</i>	Double	Longitude degree
<i>WaterDepth</i>	Double	Water depth of the temperature measured (m)
<i>Temp</i>	Double	Temperature (°C)
<i>Data_Source</i>	Text, 500	Institution/Company if Source of Data Project, database or publication where data have been

FLUID FLOW SEABED INDICATORS

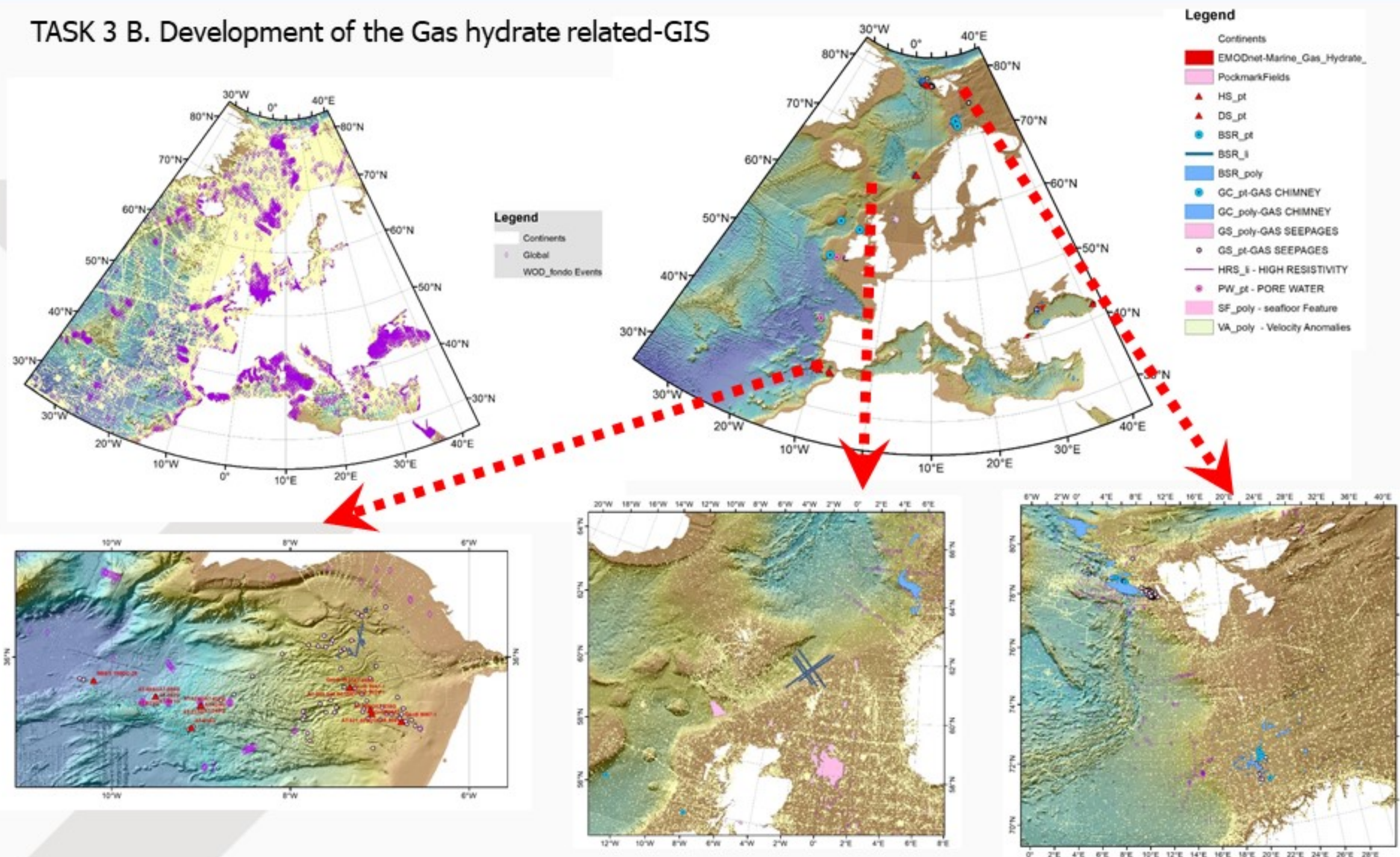
FluidFlow, Sealfloor, Poly, Features, Poly

[illegible]

FluidFlow Seafloor Point Features: Point

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<code>long_d</code>	double	longitude in decimal degrees (lat/long)
<code>longitude</code>	double	longitude (raw)
<code>lat</code>	double	latitude (raw)
<code>id_evidence</code>	Text	Geographical / Ecological setting (coordinates lat/long)
<code>id_evidence</code>	Text	local site where the evidence is located
<code>id_evidence</code>	Text	name of evidence location: "CNP, São Paulo"
<code>id_evidence</code>	Text	Geographical of the evidence: Rio de Janeiro
<code>id_evidence</code>	Text	Identification Category / Source of Data: Property, its behavior or publication where data have been
<code>id_evidence</code>	Text	Contact name
<code>id_evidence</code>	Text	Contact phone
<code>id_evidence</code>	Text	Contact e-mail
<code>id_evidence</code>	Text	URL of email data publication
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<code>id_evidence</code>	Text	Comments - Free text

TASK 3 B. Development of the Gas hydrate related-GIS



Next steps

Actions/Tasks/Deliverables	Deadline
Data loading (task 3B)	June 2020
Deliverable D3.2: Hydrate related GIS-database	(M27) Sept. 2020
Task 3C. Integration of results	Dec. 2020
D3.3: Gas Hydrate overview report	(M33) March 2021



GOBIERNO
DE ESPAÑA

MINISTERIO
DE CIENCIA, INNOVACIÓN
Y UNIVERSIDADES



Instituto Geológico
y Minero de España



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Thanks

