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## Deployment of deep enhanced geothermal systems for sustainable energy business.

G O Fridleifsson, Sigurdur G Bogason, H P Ingolfsson, P Vergnes, I Ö Thorbjörnsson, Mariane Peter-Borie, T. Kohl, E. Gaucher, T Edelmann, R. Bertani, et al.

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DEPLOYMENT OF DEEP ENHANCED GEOTHERMAL SYSTEMS  
FOR SUSTAINABLE ENERGY BUSINESS





# European Geothermal Congress

Palais de la Musique et des Congres  
Place de Bordeaux, Strasbourg

20. September 2016

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DEEPEGS Coordinator

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The DEEPEGS project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690771



# DEEPEGS Project Description

## EU SUPPORTED DEMONSTRATION PROJECT

- The goal is to demonstrate the feasibility of Enhanced Geothermal Systems (EGS) for delivering renewable energy for the European citizens
- The project will be testing stimulation technologies for **EGS in deep wells in different geological settings**

## DEMONSTRATION LOCATIONS

- The project will demonstrate advanced technologies in three types of geothermal reservoirs,
  - in high enthalpy at Reykjanes with **T** up to 550°C and
  - two deep hydrothermal reservoirs in southern France with **T** up to 220°C.

## PROJECT DETAILS

Coordinated by HS Orka, Iceland

4 year project started **December 1, 2015**

Consortium partners from

Iceland, France, Germany, Italy, and Norway

**€44.057.254**  
Total budget

**€19.999.740**  
EC Grant



Source: Herrenknecht Vertical GmbH

# DEEPEGS – Project Consortium

## Partners

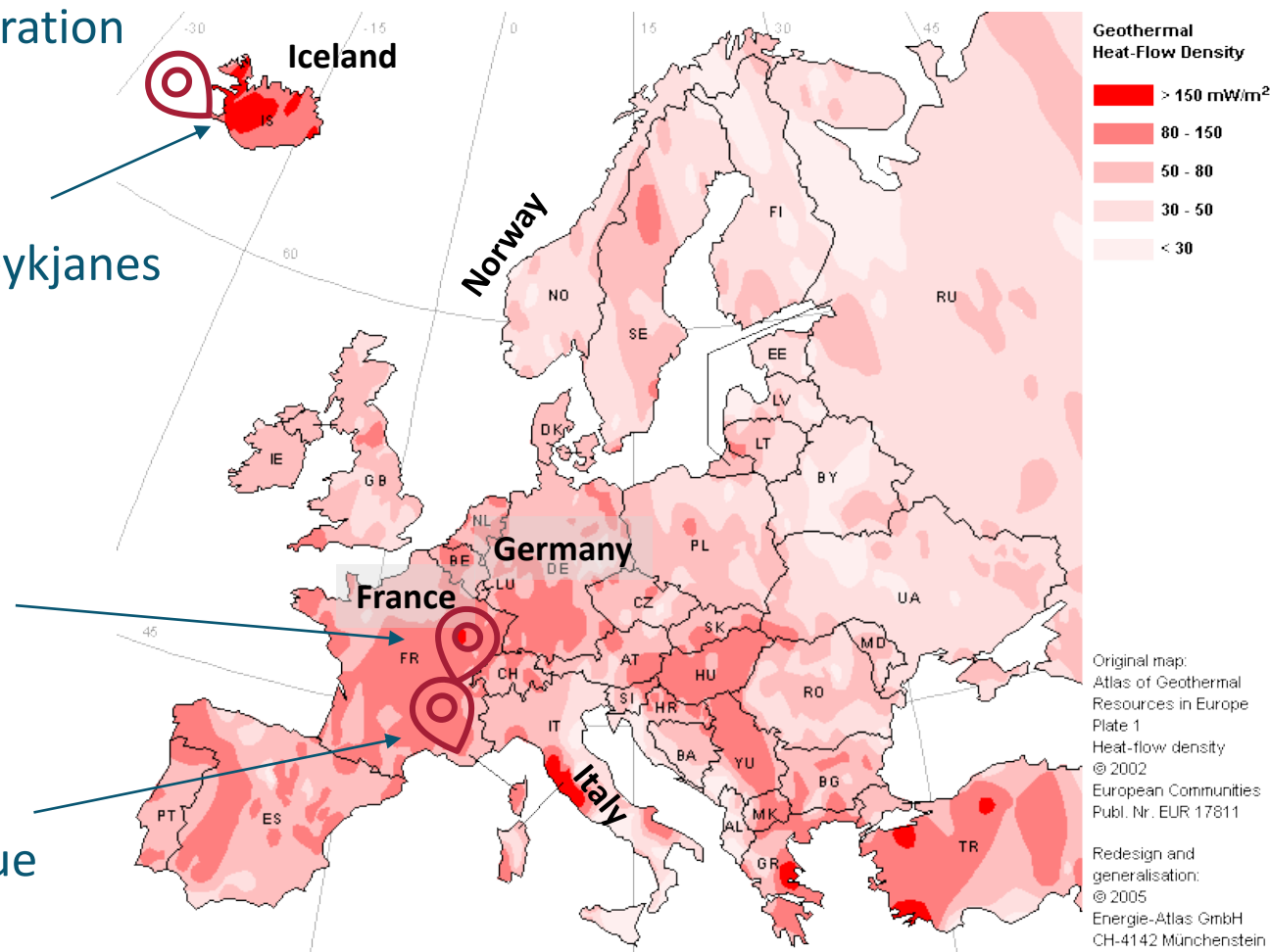
- **Iceland:**
  - HS Orka
  - ISOR
  - GEORG
  - Landsvirkjun
- **France:**
  - BRGM
  - Fonroche Geothermie
- **Germany**
  - Herrenknecht Vertical
  - Karlsruher Institut fuer Technologie
- **Italy**
  - Enel Green Power
- **Norway**
  - Statoil Petroleum

## Demonstration sites

Iceland:  
RN-15 Reykjanes

France:  
Valence

France:  
Vistrenque



# DEEPEGS – Industry driven consortium

Energy Companies



Supporting Companies & Research Entities





## AMBITION

- Develop a **future approach to geothermal energy** by implementing deep EGS methodologies,
- Laying the **foundation of a novel geothermal engineering** allowing widespread exploitation of deep heat resources for improved energy security.



## BUSINESS MODEL TO BE CREATED

- Robust business models for EGS wide spread deployments will be developed
- Showcasing Business Case demonstrators of EGS for deep geothermal energy
- Feasibility frameworks for exploitation in different geological areas/conditions
- Market analysis and cost-benefit assessments for wider deployments of EGS in Europe and world wide

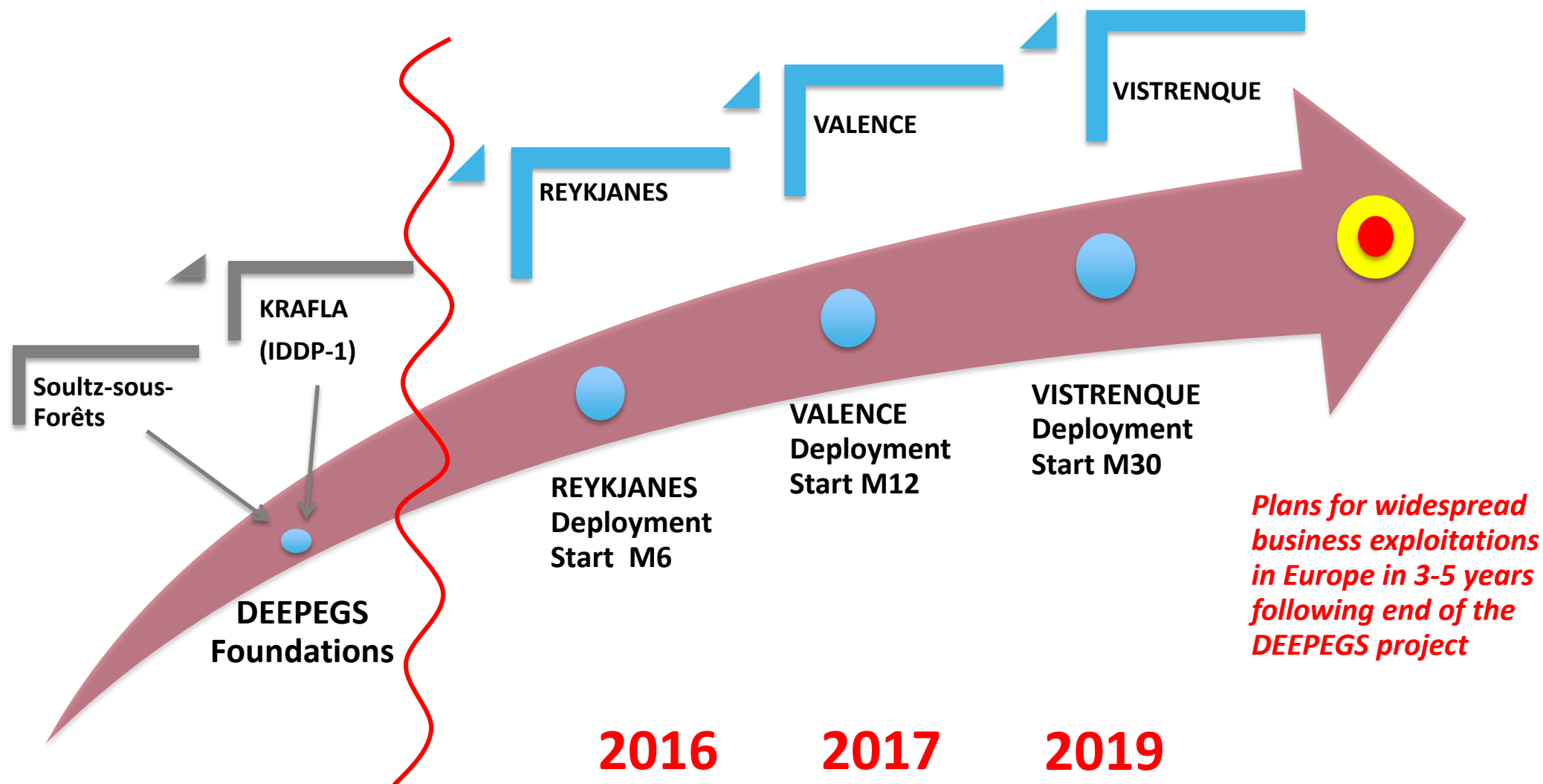


## EXPECTED IMPACT

- **Bring down cost** of renewable energy and **increase the attractiveness** of renewable heating and cooling technologies
- Reduce life-cycle environmental impact
- Improve EU **energy security**
- Make renewable electricity generation **more predictable**
- Strengthen the European industrial technology base

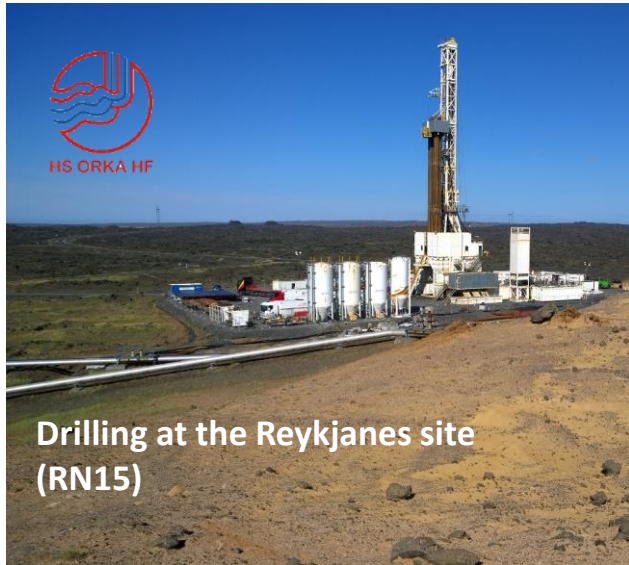


# DEEPEGS - Timeline





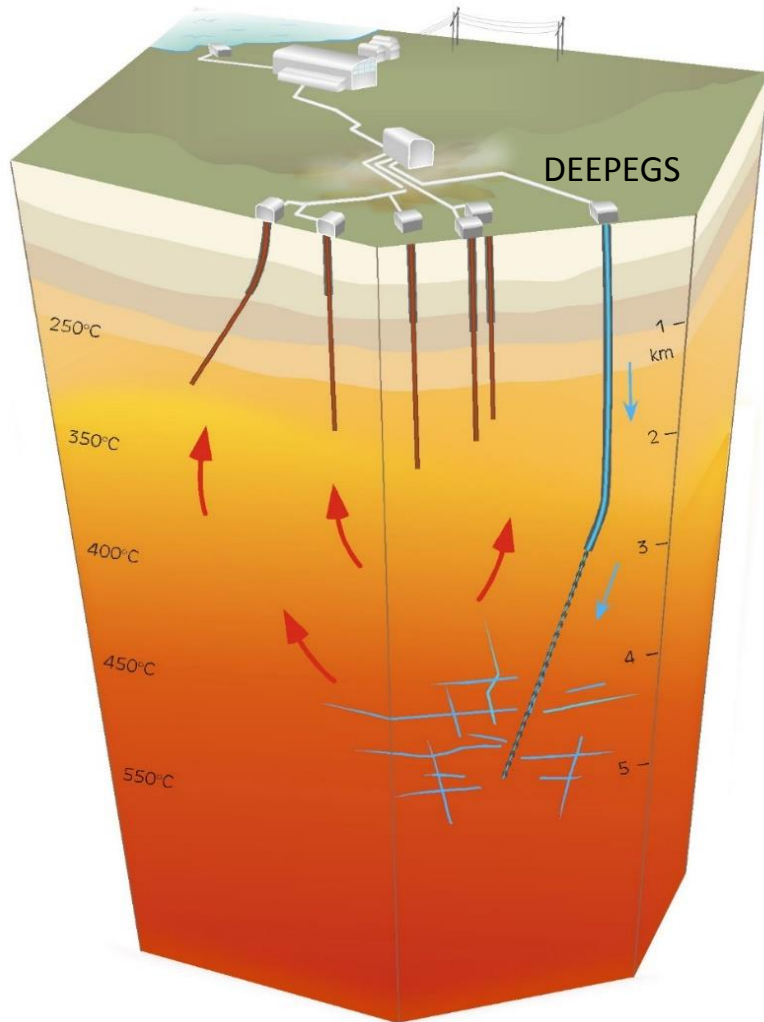
# DEEPEGS Scope



## MAIN TARGETS

- DEEP DRILLING IN REYKJANES ICELAND → 5 KM
  - Deep **EGS stimulation** in an existing geothermal field with number of production wells,
  - Power plant on site with existing 100 MW capacity,
  - Through EGS **increase** the available energy output,
  - Demonstrate this business case in a high enthalpy geological environment.
  
- DEEP DRILLING OF DOUBLETS IN **TWO DIFFERENT GEOLOGICAL ENVIRONMENTS IN FRANCE**
  - **Target depth** at both demonstration sites → 5 KM +
  - **Soft EGS** stimulation to enhance energy recovery,
  - Demonstrate that deep EGS will enable access to deep geothermal energy in France → *business case for wider deployments in Europe.*

# RN-15: Production well: offered for deepening as IDDP-2 DEEPEGS demonstration well



Reykjanes power plant: 100 MW<sub>e</sub>

RN-15 production well: 2.5 km deep

RN-15 defined as Well of opportunity for IDDP-2 / DEEPEGS

It will be directionally drilled to 5 km depth in 2016

Flow tested in both directions – down and up

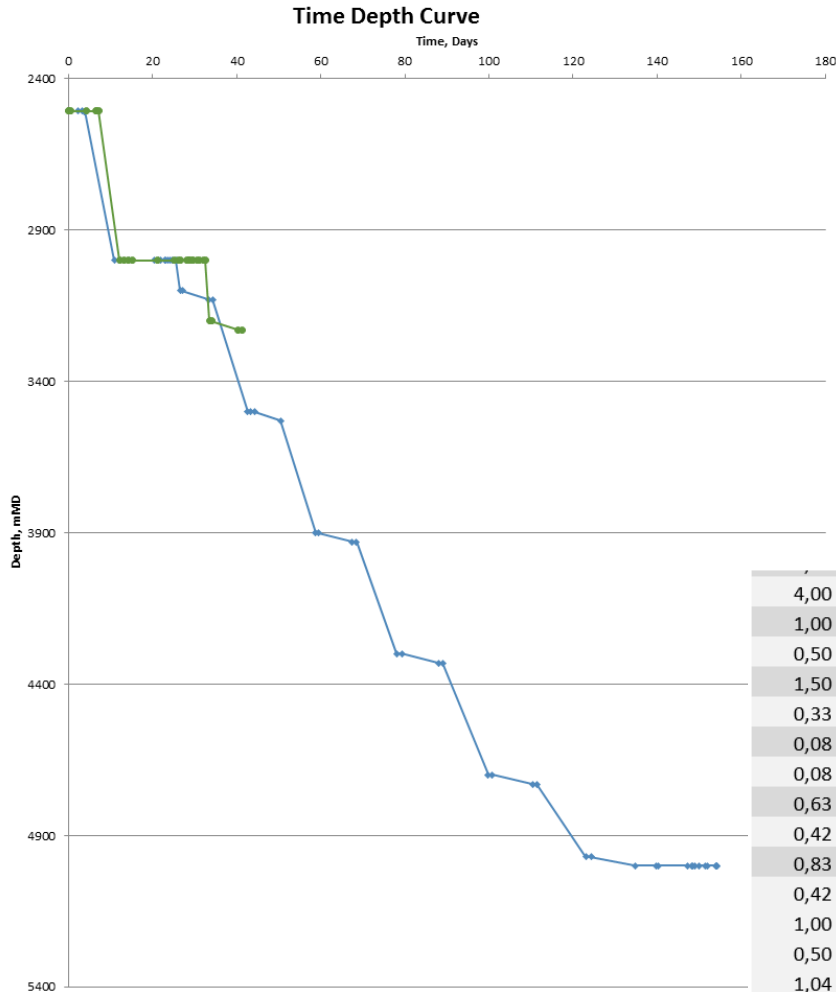
Pilot tested for power production

Scientifically studied as a black smoker analog

Reservoir fluid is of seawater origin

19 September 2016

# PROGRESS TO DATE



4,00	25,2	96	RIH 9 7/8" - 9 5/8" casing and cables	3000	3000	0	1.9.2016	5.9.2016
1,00	26,2	24,0	Circulation and cooling well before cementing	3000	3000	0	5.9.2016	6.9.2016
0,50	26,7	12	Cementing casing reverse to surface	3000	3000	0	6.9.2016	6.9.2016
1,50	28,2	36,0	WOC, logging temp and CBL	3000	3000	0	6.9.2016	8.9.2016
0,33	28,5	8	"Cut" Casing and nipple down BOP's	3000	3000	0	8.9.2016	8.9.2016
0,08	28,6	2	Remove 13 5/8" flange	3000	3000	0	8.9.2016	8.9.2016
0,08	28,7	2	Install 9 7/8" flange	3000	3000	0	8.9.2016	8.9.2016
0,63	29,3	15	Nipple up 13 5/8" 5000 psi BOP's, including centralizer flange and test BOP	3000	3000	0	8.9.2016	9.9.2016
0,42	29,7	10	Make up 8 1/2" rotary BHA for drill out cement	3000	3000	0	9.9.2016	9.9.2016
0,83	30,5	20	Drill out cement and POOH	3000	3000	0	9.9.2016	10.9.2016
0,42	31,0	10	RIH cement string for cementing below casing	3000	3000	0	10.9.2016	10.9.2016
1,00	32,0	24	Cement below casing and POOH + brake out DP	3000	3000	0	10.9.2016	11.9.2016
0,50	32,5	12	Make up 8 1/2" DD BHA, RIH	3000	3000	0,00	13.9.2016	14.9.2016
1,04	33,5	25	Drill out cement, DD AB 1,5°/30m, MAB 16°, Azi 210°, @ 16° hold to TD	3000	3200	200	14.9.2016	15.9.2016
0,50	34,0	12	POOH	3200	3200	0	15.9.2016	16.9.2016
6,25	40,3	150	Makeup coring assembly, coring & tripping x 3 runs, about 30 m, POOH	3200	3230	30	16.9.2016	22.9.2016

# Reykjanes

- Preparation for drilling
  - ✓ Final design → selection of materials/methods → purchasing materials → receive on site
  - ✓ Cabled thermocouples added on the outside of the casing – Temperature tolerance up to 600°C
  - ✓ Decision made to use IMAGE funded fibre optic cable to 900 m outside casing – GFZ personnel funded by GEOWELL
- Drill rig on site in late July
  - ✓ Drilling operation formally began 11.08.2016
  - ✓ 3 km casing depth reached 23.08.2016
  - ✓ Cementing of casing completed 06.09.2016
  - ✓ Cement being drilled out today - 09.09.2016
  - ✓ Public meeting before drilling held at Reykjanesbaer on 4th August, 2016



- Monitoring
  - ✓ Accelerometer set up in the nearest village (Grindavik) some 12 km from drill site.
  - ✓ Seismic network expanded by ISOR close to the drill site, and network expanded by 3 seismometers and MT monitoring station from KIT
  - ✓ Gas monitoring equipment during drilling supplied by ICDP and set up – we fund transporting of the tools
  - ✓ Conductivity and pH monitoring during drilling added

# Valence

- Seismic acquisition in Valence, first geophysical investment in this area since the 80's

- ✓ Done in July 2016
- ✓ 9 - 2D seismic lines for ~95km total length
- ✓ Interpretation ready for T1 2017
- ✓ → good quality acquisition



# Thank you!

For more information please contact us via



[www.deepegs.eu](http://www.deepegs.eu)



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