GeoWell

Innovative materials and designs for long-life high-temperature geothermal wells

Project Coordinator: ÍSOR

The Deep Roots of Geothermal Systems, Open Conference, 18-19 February 2016

Árni Ragnarsson

ÍSOR – Iceland GeoSurvey

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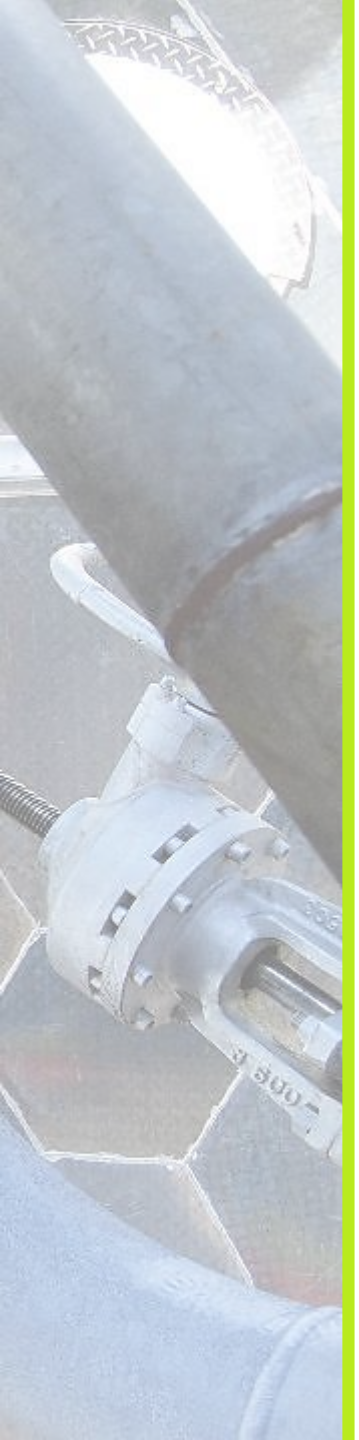

Content

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  - Objectives
  - Consortium
  - Planned input of resources
- Short description of each technical work package, WP2 – WP6

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- Horizon 2020 Call LCE 2 – 2014/2015:
  - Developing the next generation technologies of renewable electricity and heating/cooling
  - Technology category: Deep geothermal energy - Development of new technologies and concepts for geothermal energy
- Starting date: 1 February 2016
- Duration: 36 months
- Budget: 4.7 million €

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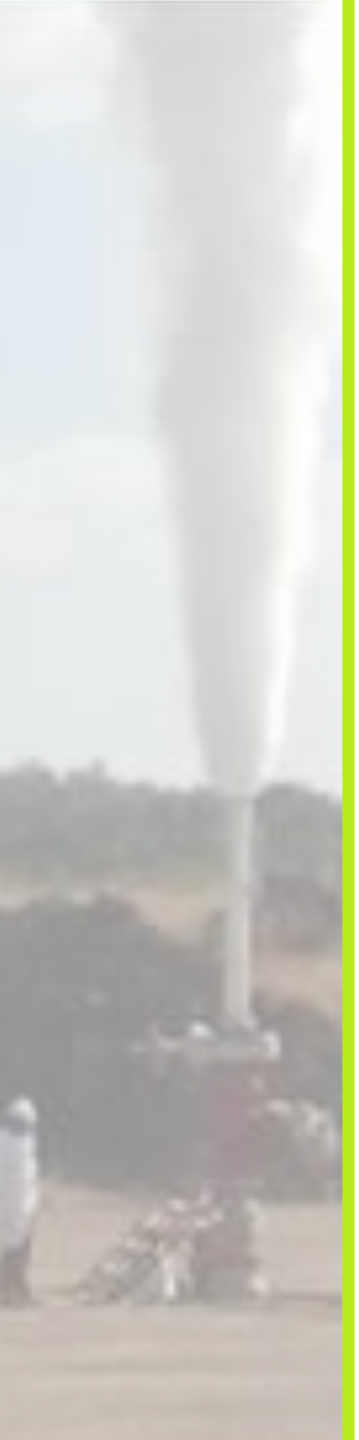

GeoWell objectives

GeoWell aims to develop reliable, economical and environmentally friendly technologies for design, completion and monitoring of high-temperature geothermal wells:

- Cement and sealing technologies
- Material selection and coupling of casings
- Temperature and strain measurements in wells using fibre optic technologies to monitor well integrity
- Development of methods for assessment of risk related to design and operation of high-temperature geothermal wells
- The technology developed will be tested in laboratories and partly in real geothermal environment (TRL level from 3-4 to 4-5)

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GeoWell consortium

	Partner	Partner's name	Country
1	ISOR	Íslenskar orkurannsóknir - Iceland GeoSurvey	Iceland
2	IRIS	International Research Institute of Stavanger AS	Norway
3	GFZ	Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum	Germany
4	TNO	Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek	Netherlands
5	BRGM	Bureau de Recherches Geologiques et Minieres	France
6	STATOIL	Statoil Petroleum AS	Norway
7	HS ORKA	HS Orka hf.	Iceland
8	AKIET	Akiet BV	Netherlands
Third Parties			
	SINTEF	The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology	Norway
	EGP	Enel Green Power	Italy

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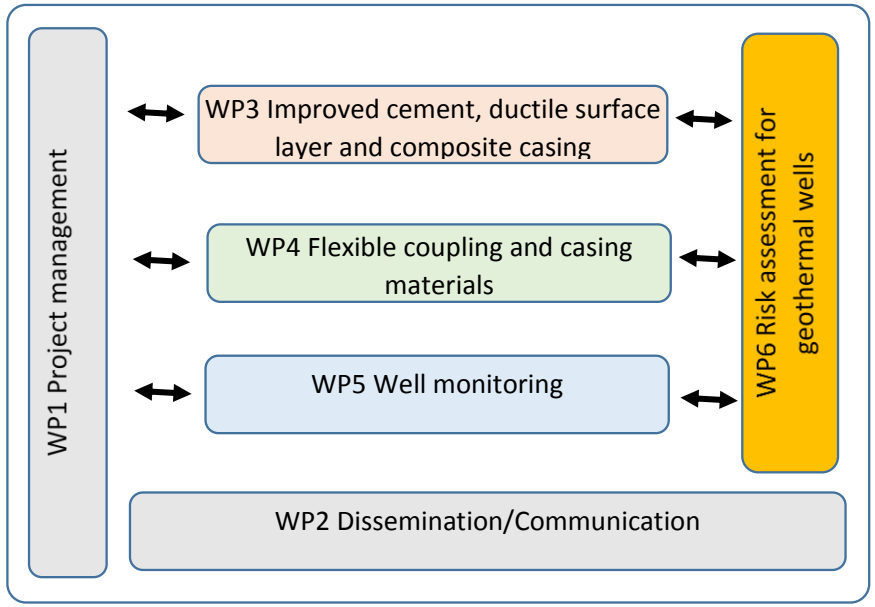
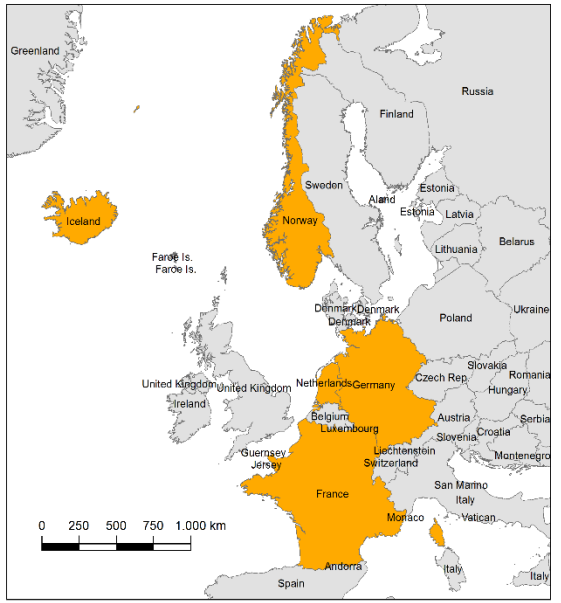
GeoWell project

WP	Title	WP leaders	
WP1	Project management	ISOR	Árni Ragnarsson
WP2	Dissemination/Communication	BRGM	Pierre Durst
WP3	Improved cement, ductile surface layer and composite casing	TNO	Jens Wollenweber
WP4	Flexible coupling and casing material	ISOR	Ingolfur Thorbjornsson
WP5	Well monitoring	GFZ	Thomas Reinsch
WP6	Risk assessment for geothermal wells	IRIS	Erlend Randeberg





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GeoWell efforts in person-months

	ISOR	IRIS	GFZ	TNO	BRGM	STATOIL	HS ORKA	AKIET	Total	%
WP1 - Project management - ISOR	26	1	1	1	1	0.5	0.5	0.5	31.5	8.6
WP2 - Dissemination/Communication – BRGM	2	0.5	0.5	0.5	7.5	0	0	0	11	3.0
WP3 - Improved cement, ductile surface layer and composite casing – TNO	13	2	0	38	12	8	2	40	115	31.4
WP4 – Flexible coupling and casing materials – ISOR	55	0	2	12	6	12	6	0	93	25.4
WP5 - Well monitoring – GFZ	2	0	60	6	0	0	1	0	69	18.8
WP6 - Risk assessment for geothermal wells – IRIS	4	33	4	4	0	2	0	0	47	12.8
GeoWell total	102	36.5	67.5	61.5	26.5	22.5	9.5	40.5	366.5	100.0
%	27.8	10.0	18.4	16.8	7.2	6.1	2.6	11.1	100.0	

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GeoWell budget (€) (1/2)

	ISOR	IRIS	GFZ	TNO	BRGM	STATOIL	HS ORKA	AKIET	Total	%
WP1 - Project management - ISOR	294,375	14,325	7,933	7,883	9,500	11,500	6,329	4,413	356,257	7.6
WP2 - Dissemination/Communication – BRGM	26,875	7,163	3,966	4,039	108,750	0	0	0	150,793	3.2
WP3 – Improved cement, ductile surface layer and composite casing – TNO	171,563	28,650	0	418,068	114,000	284,000	25,318	421,750	1,463,348	31.1
WP4 – Flexible coupling and casing materials – ISOR	551,563	0	15,865	140,125	57,000	338,500	276,578	0	1,379,630	29.3
WP5 - Well monitoring – GFZ	39,375	0	495,514	115,898	0	0	37,659	0	688,446	14.6
WP6 - Risk assessment for geothermal wells - IRIS	41,250	496,475	37,980	44,735	0	46,000	0	0	666,440	14.2
GeoWell total	1,125,000	546,613	561,258	730,748	289,250	680,000	345,883	426,163	4,704,914	100.0
%	23.9	11.6	11.9	15.5	6.1	14.5	7.4	9.1	100.0	

GeoWell budget (€) (2/2)

	Cost	%
Personnel cost	2,897,431	61.6
Travel	130,000	2.8
Equipment	275,000	5.8
Other goods and services	341,500	7.3
Subcontracting	150,000	3.2
Overhead (25%)	910,983	19.4
GeoWell total	4,704,914	100.0

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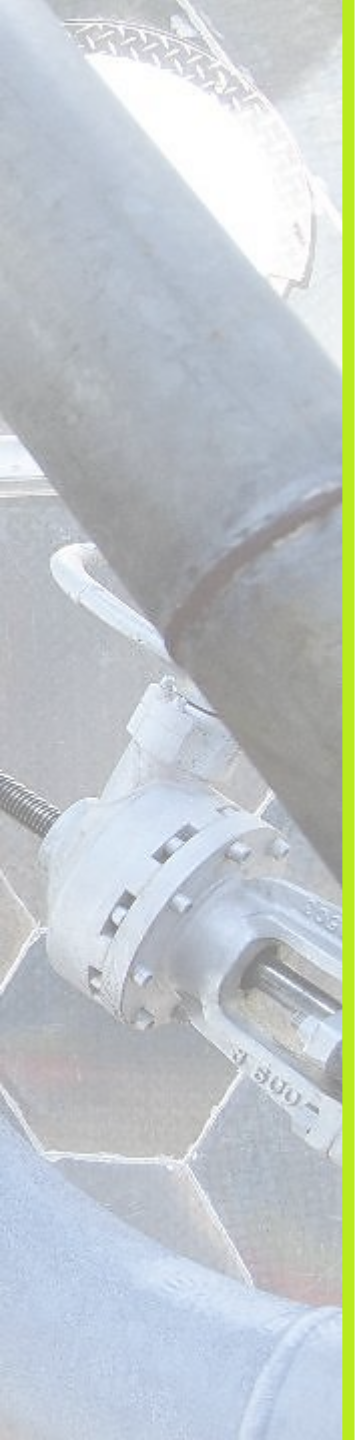
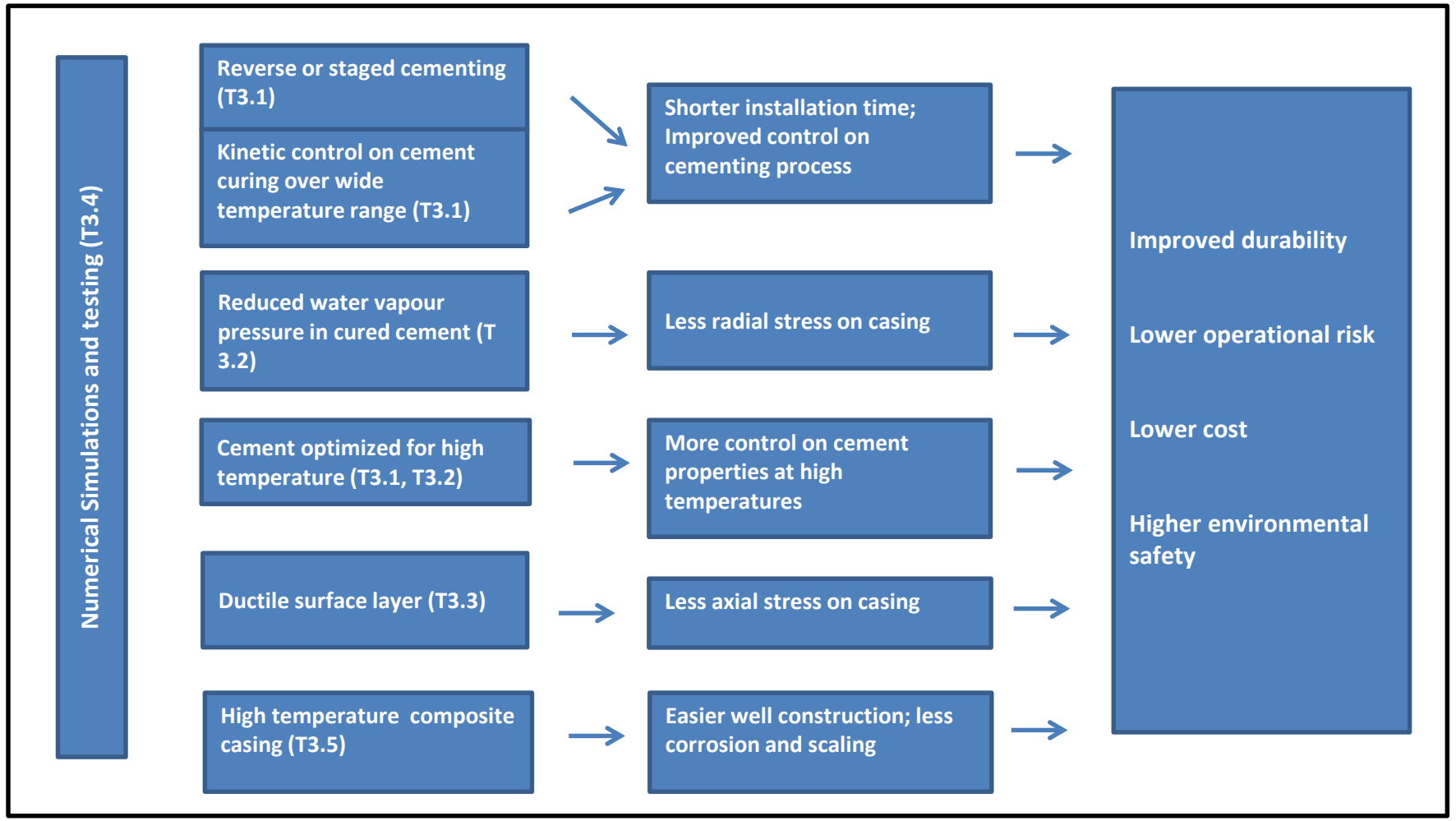


WP3 - Improved cement, ductile surface layer and composite casing



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WP3 - Main tasks and goals

- Improved cement curing kinetics - goal:
  - Reduce time for cementing from 5-7 days to 2 days
- Cement with reduced supplementary water pressure - goal:
  - Reduce supplementary pressure in the cement sheath from currently >100 bar to ideally below 30 bar
- Ductile intermediate layer - goal:
  - Allow movement of casing with respect to cement on expansion while ensuring zonal isolation
- Testing and prediction of behaviour of cured cement - goal:
  - Requirements for properties of cement and intermediate layer and a model of geochemistry of cement for high temperatures
- High temperature composite casings - goal:
  - Increase application temperature of composite casings from around 85°C to around 170°C

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WP4 - Flexible coupling

To design and test flexible couplings for high temperature geothermal well that can:

- Withstand mechanical stresses during running of casing in well
- Allow axial movement of casing segments due to thermal expansion of the casing material with below yield stress on casing material
- Allow quenching of the well with minimal risk for tearing the couplings threads
- Allow gas – mud – water – concreate tight connection during running casing, during drilling and concreate work and in operation

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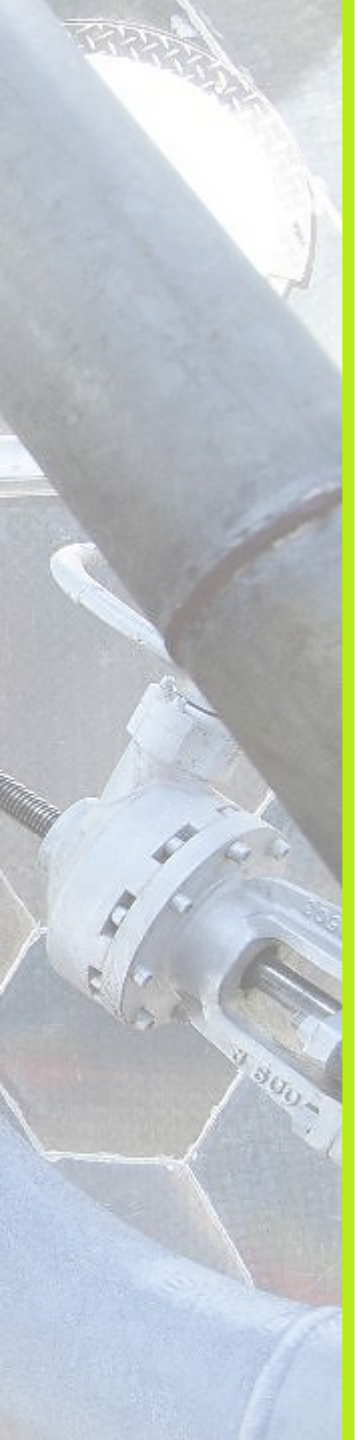

WP4 - Material performance

To select candidate materials and especially based on material combinations, cladded material

- Compile list of materials suitable for downhole conditions
- Test in environmental chamber mechanical properties of candidate materials at selected higher temperatures
- Autoclave testing of materials if needed
- Prepare downhole in situ testing of the selected materials

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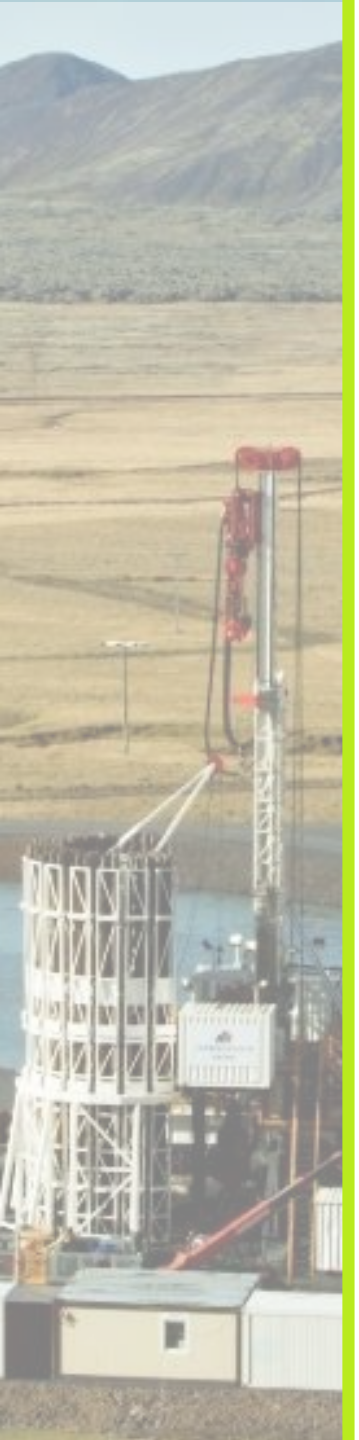

WP4 - Cladded materials

Test and evaluate cladded material combinations in real geothermal environment

- Design test parameters – stressed and unstressed testing
- Test materials in laboratory
- Test materials in situ
- Evaluate material performance – cladded
- Rank cladded materials

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WP5 - Well monitoring - Objectives

- Analyse structural integrity of geothermal wells
  - Focus on cement and casing
- Measure relevant parameters during load changes, i.e. beginning of fluid production
- On-line monitoring of performance of casing and cement and identification of processes influencing the well integrity
  - Parameters: Temperature, Strain, Noise
  - Method: Distributed fibre optic sensing behind casing

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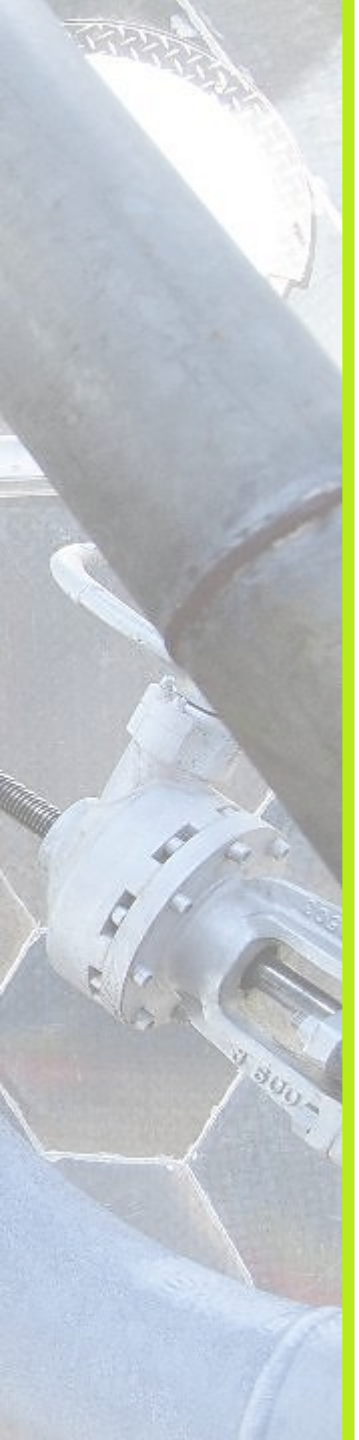

WP5 - EDAS Development

Based on an existing proof-of-concept laboratory set-up a demonstrator for distributed acoustic sensing will be developed to be integrated in well integrity evaluation:

- Testing and optimization of the current design
- Hardware selection and procurement
- Development of algorithms to handle large amount of data
- Integration and testing in laboratory environment (TRL level 3, API 17N)
- Packaging of components for transport and field use
- Verification and test of breadboard system before shipping

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WP5 - Casing and cement integrity evaluation

- Calibration measurements for simultaneous strain and temperature measurement
- Laboratory measurements on strain and temperature under simulated well conditions
- Field measurements on strain and temperature at low temperature well conditions
- Installation of sensing cable behind casing of a geothermal well
- Measurement of strain and temperature during the cement job of a geothermal well
- Measure strain, temperature and noise during flow testing/injection testing within geothermal wells

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WP6 - Risk assessment for geothermal wells (1/2)

Main objectives:

- Raise the standard of risk analysis tools for geothermal wells to a standard that is comparable to that of oil & gas wells and propose a risk management framework that can be used for any deep geothermal well
- Evaluate and manage risk related to the introduction of new materials and tools developed in WP3 and WP4

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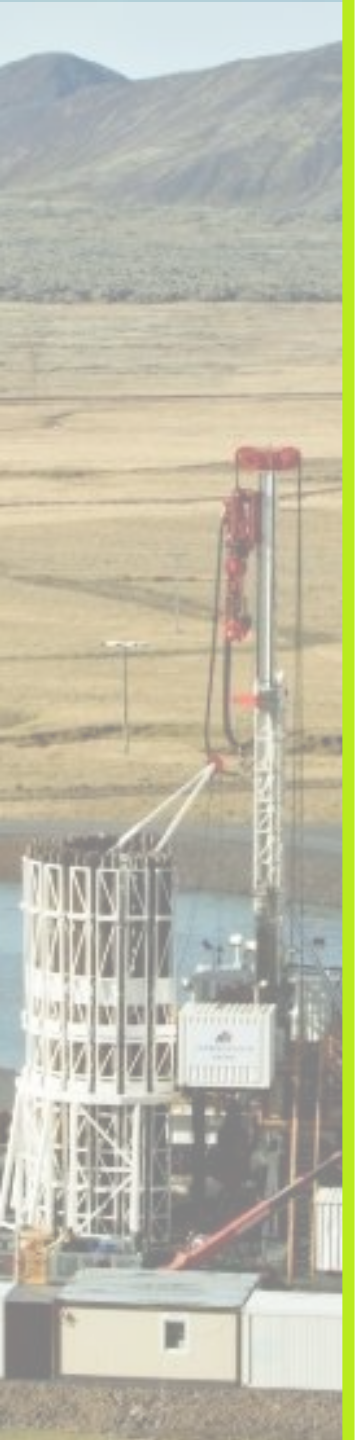

WP6 - Risk assessment for geothermal wells (2/2)

Main tasks:

- Map the status and availability of risk assessment methods for geothermal wells
- Identify and evaluate risk assessment methods that can be transferred from the oil & gas domain to the geothermal domain
- Develop risk assessment methods for high temperature phenomena in geothermal wells
- Evaluate European regulations and standards on geothermal well integrity and risk assessment requirements and propose improvements
- Risk and reliability analysis of the new materials developed in the project

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THANK YOU