



Energize the CEE Region Focusing Reliable Energy Security

Workshop

16-17 November 2023, Visegrád

Society of Petroleum Engineers

Radial Drilling in RAG Austria: operator perspective

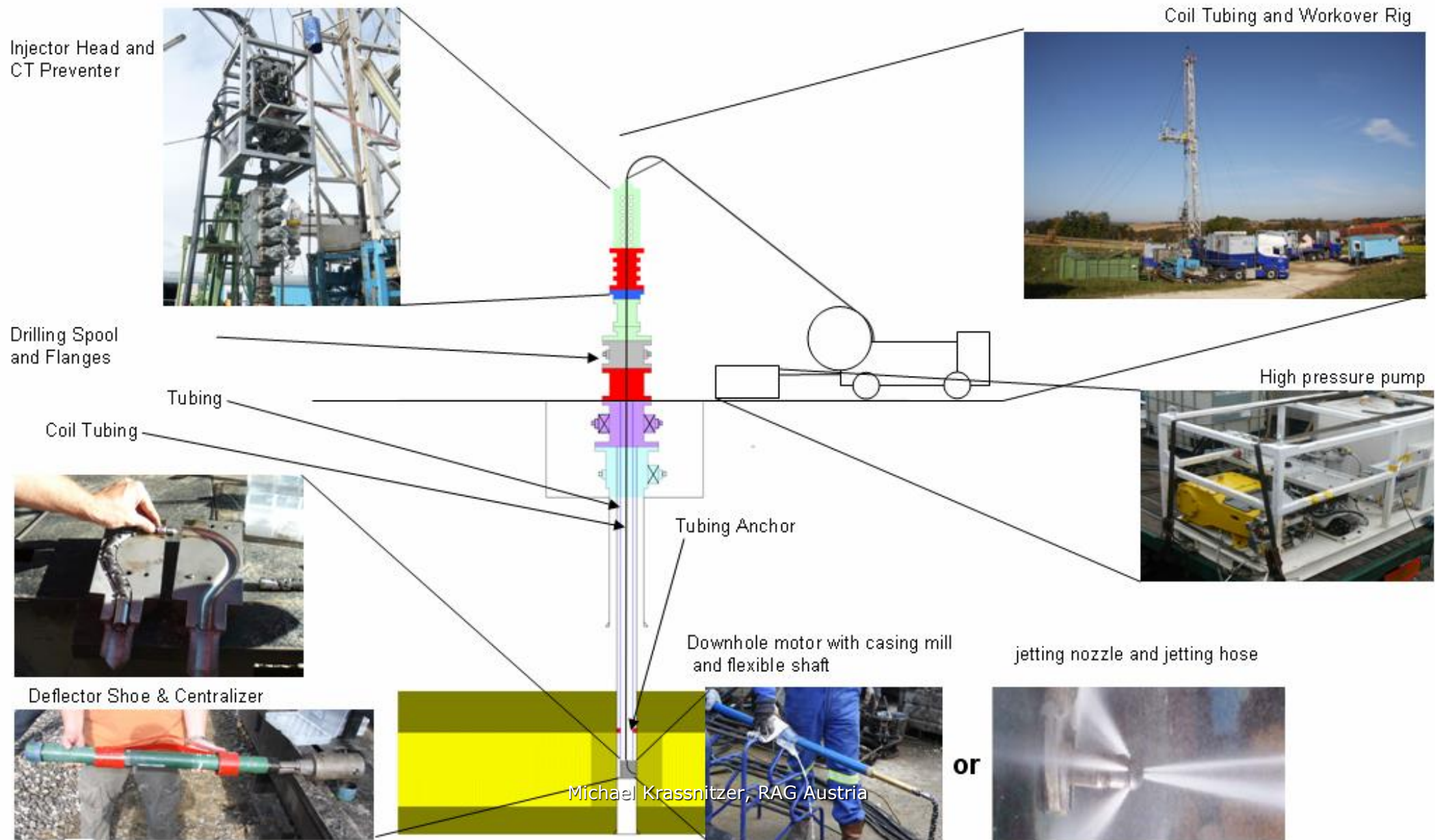
■ Agenda

- RAG Austria Company profile
- Radial Drilling technology overview
- Radial Drilling technology in RAG Austria
- Screening studies for low perm reservoirs
- Results
- Conclusions

RAG Austria Company profile

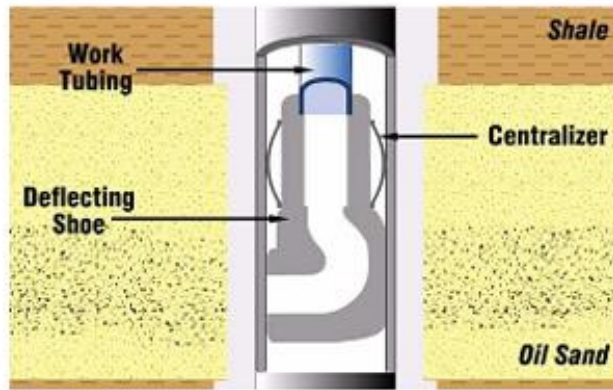
- RAG Austria AG is Austria's largest energy storage company, and one of Europe's leading gas storage facility operators
- gas storage capacity of about 6.3bn m3 of natural gas (~6% of total capacity in the EU) in 11 storage sites
- Developer of leading edge energy technologies related to "green gas" that partner renewables
 - Underground Sun Storage and Underground Sun Conversion
 - Methane Electrolysis
- Operator of ~27 oil fields (86wells) and 33 gas fields (93wells)

Radial Drilling Technology (1)

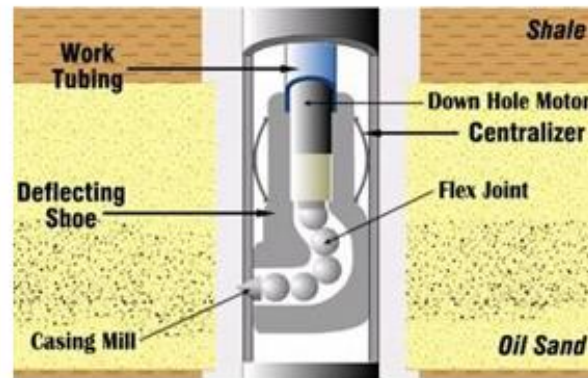


Radial Drilling Technology (2)

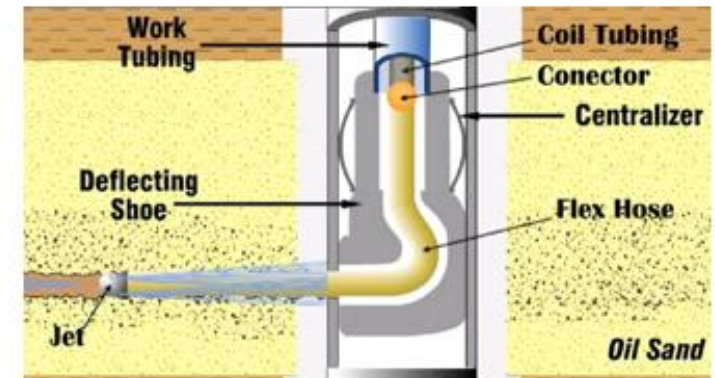
1. Landing



2. Milling



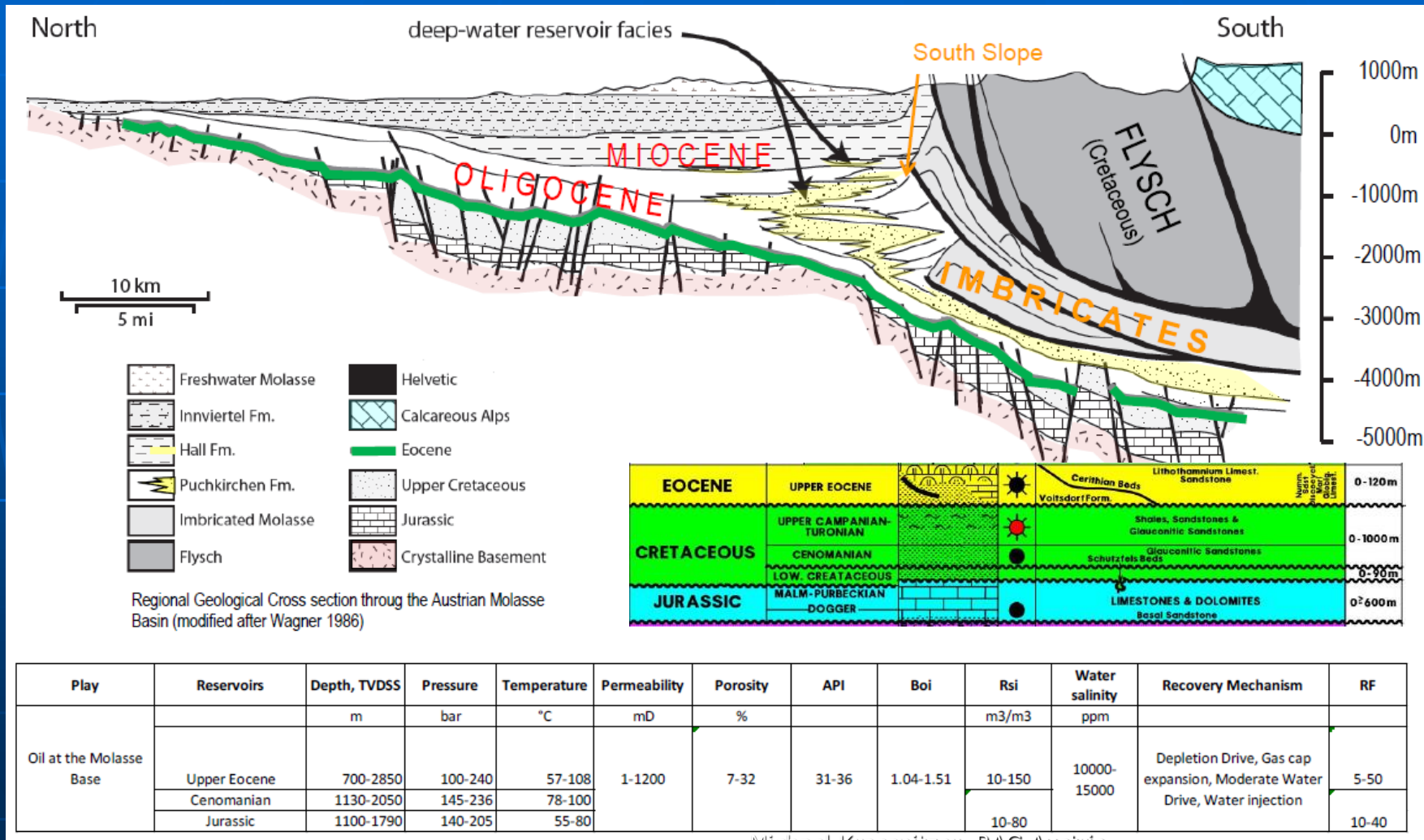
3. Jetting-In/Out



Radial Drilling Technology in RAG Austria

- Incentives of technology application:
 - “connect” compartmentalized Reservoirs
 - Improve well deliverability of low perm reservoirs

Radial drilling in RAG Austria: Improve well deliverability of low perm reservoirs

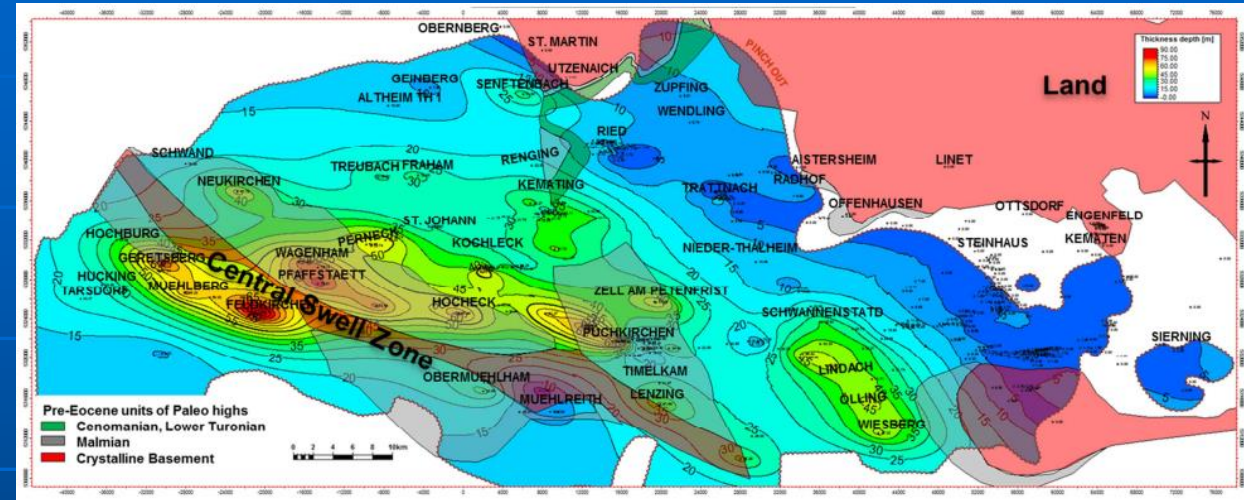
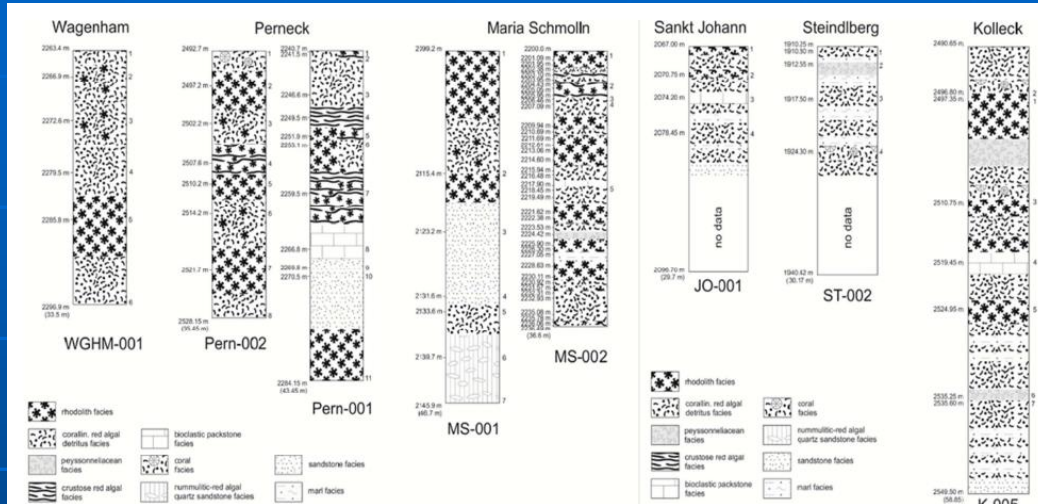


- Low hanging "oil" almost depleted → focus on "more difficult" oil/reservoirs

Screening of Lithothamnium limestone potential

Facies Distribution study

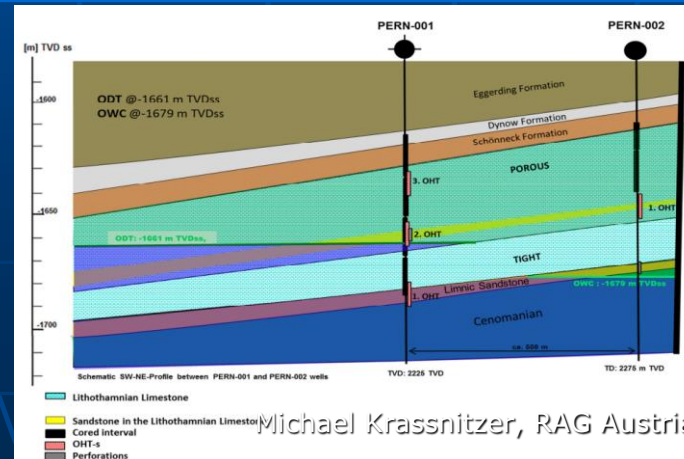
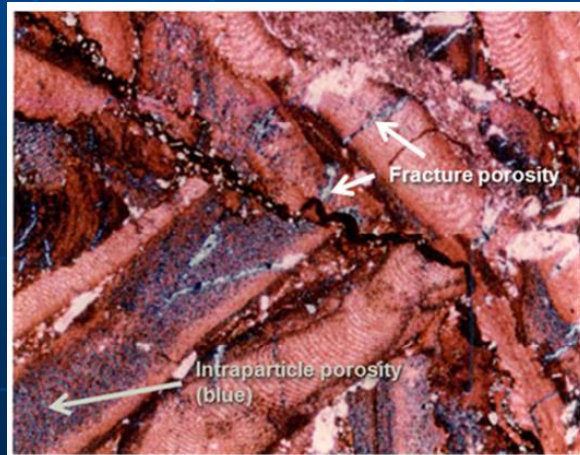
Mapping of Lithothamnium Limestone



Porosity study

Review of well test data

Radial Drilling Core tests



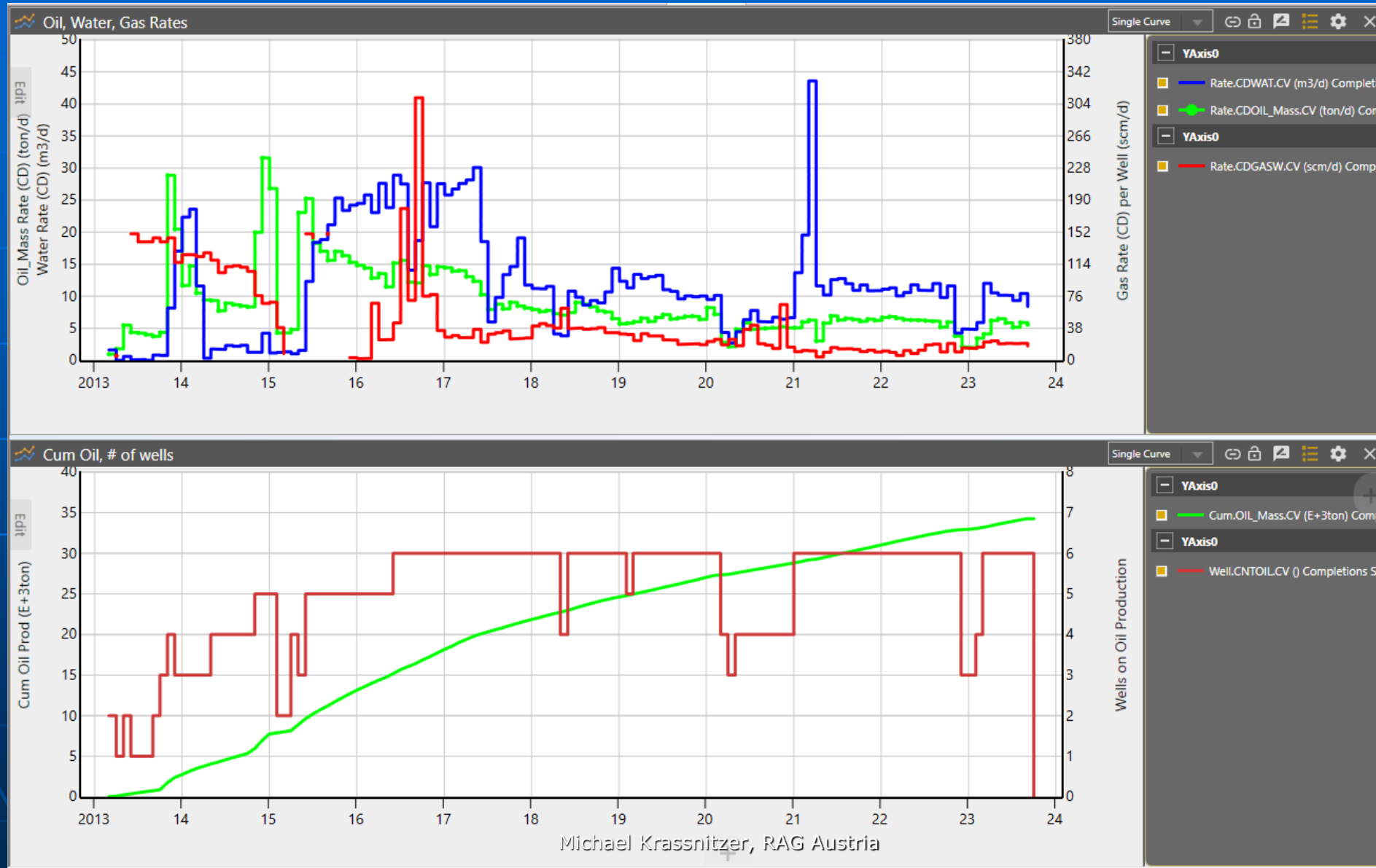
Michael Krassnitzer, RAG Austria

Results summary

well	date	Formation	Depth mMD	Casing diameter	# & length of laterals m	starting rate t/d; bbl/d	current rate t/d; bbl/d	Cum. Prod. kt	UR kt	Comments
BH-N-002	October 2008	Sandstone	ca. 1860	7"	1x42/1x94/1x97/1x100					6 attempts four successful, 2 times milling not successful, no recognizable production increase
TRAT-010	March 2009	Sandstone	ca. 1600	7"	1x94/1x98/1x100/1x99	0.5/3.5		0.3	0.3	marginal increase of production rate, after a few months back to previous decline
STRAS-002	March 2009	Sandstone	ca. 1170	7"	1x93/1x97/1x96/1x88					no reservoirs were encountered with the laterals
MS-002	March 2013	Limestone	ca. 2200	7"	1x50/1x58/1x60	4.4/31	1/7	7.9	9	4 laterals planned, CT failure/burst @ 4th lateral
KTG-002	Sep.13	Limestone	ca. 1810	7"	4x60	2.6/18	1/7	5.4	8.7	
KTG-004	Sep.13	Limestone	ca. 1850	7"	4x60/1x12	3/21	1/7	4.2	7	
PERN-002	March 2014	Limestone	ca. 2500	7"	2x100/1x38/1x17/1x40	20/140	1.3/9	12.5	18	
R-005	March 2014	Limestone	ca. 1410	6 5/8"	1x72/2x70/1/74					connected to the high Perm watered out underlying reservoir
SIER-006	March 2014	Sandstone	ca. 660m	7"	3x91/3x100/1x90/1x3					no production benefit
KTG-W-002	Nov.15	Limestone	ca. 1830	7"	2x70	4/28	2/14	5	11	4 laterals planned, downhole motor failure
P-033	Nov.15	Sandstone	ca. 2580	4 1/2"	not succesful					3 attempts to mill Casing, not successful

technical success & production improvement
technical success, no production improvement
technical failure

Results: production performance



Radial Drilling in RAG Austria: conclusions (1)

Technical aspects

- Equipment limitation: 7" Casing
- Development of smaller diameter equipment: last campaign 4 ½": not successfully applied
- Overall jetting success rate 74%
- Limited possibilities to monitor contribution of laterals
- Lack of steering control resulted in one well connecting to underlying watered out reservoir

Production Performance

- Uneconomical wells/zones → economical wells after RD application
- Production performance of LTK wells improved by a factor of 2-3.
- All sandstone applications unsuccessful → immediate collapse of lateral?
- All gas applications unsuccessful (gas candidates also in sandstone reservoirs); i.e. finding & connecting different compartments failed

Radial Drilling in RAG Austria: conclusions (2)

■ General remarks:

- It works/worked: collaboration/supervision of service companies important
- Affordable appraisal tool/technology
- Certain limitations, i.e. minimum casing diameter, steerability (operating in the „blind“), monitoring of progress/results (contribution of laterals)