



SMRI **SPRING**
2024

KRAKOW | POLAND
— **APRIL 21-24** —

CONFERENCE SCHEDULE

All times in Central European Summer Time (CEST)

Saturday, April 20

8:00 AM – 12:30 PM **RESEARCH COMMITTEE MEETING**
1:00 – 4:30 PM **LEADERSHIP MEETING**

Sunday, April 21

8:00 AM – 5:00 PM **SMRI TECHNICAL CLASS**
Hydrogen Cavern Storage Considerations
*Optional with additional charge;
repeated from the Fall 2023 Conference*

Monday, April 22

8:00 – 10:00 AM **BUSINESS MEETING**
Members Only
10:30 AM – 5:00 PM **TECHNICAL PAPER PRESENTATION**
9:45 AM – 1:00 PM **FRIENDS AND SPOUSES ACTIVITY**
5:45 PM – 11:30 PM **MONDAY CONFERENCE EVENING EVENT**
Optional; additional charge

Tuesday, April 23

8:00 AM – 4:30 PM **TECHNICAL PAPER PRESENTATION**
9:45 AM – 2:30 PM **FRIENDS AND SPOUSES TOUR**

Wednesday, April 24

8:00 AM – 5:30 PM **FIELD TRIP 1** : Wieliczka Salt Mine and Wawel
8:30 AM – 5:30 PM **FIELD TRIP 2** : Bochnia Salt Mine and Wawel

CONTACT

CONFERENCE ASSISTANCE

SMRI Membership Issues

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Registration Assistance

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PROGRAM QUESTIONS CONTACT

Program Chair 2024

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CLASS QUESTIONS CONTACT

Technical Class Chair 2024

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REGISTRATION INFORMATION

IN-PERSON ATTENDEES

All conference attendees must be in the SMRI database and register online in advance, with payment required for confirmation. Non-technical guests must be registered as "guests" before finalizing the online payment. Event space is limited. The delegate registration fee includes access to Sunday Icebreaker, breakfast if registered at the DoubleTree with SMRI code, AM/PM breaks, and Monday and Tuesday lunches. Registering after April 5 incurs a \$250 additional charge, subject to space availability.

REMOTE ATTENDEES

SMRI plans to broadcast the Krakow meeting in a hybrid format. Technical Presentations will be live-streamed, with on-demand access later. The same platform as the San Antonio event will be used, and details will be shared closer to the conference date. Virtual attendees must register separately with a link on the registration page. The remote delegate registration fee is the same as in-person rates, covering live feed broadcast, on-demand videos, and a file of all presented papers. Register before 5 April to avoid additional \$250 charge. *The Technical Class will be live-streamed only and not available on-demand afterward.*

conference pricing

MEMBER COST: \$650
(\$500 w/o Monday Night Event)

NON-MEMBER COST: \$1,100
(\$950 w/o Monday Night Event)

Discounts available for Class Instructors and one Speaker per paper. University students contact John Nadeau (jnadeau@solutionmining.org) to apply for discounted registration.

registration dates

14 FEBRUARY
Member registration begins

13 MARCH
Non-member registration begins

5 APRIL
Registration ends;
no refunds after this date

HOTEL & TRAVEL DETAILS

HOTEL

DoubleTree by Hilton Krakow
Dąbska 5, 31-572 Kraków, Poland

SMRI RATE	RESERVATIONS
\$119.00	+48 12 201 40 00

[Click to Book Hotel](#)

AIRPORT

Krakow Airport (KRK), situated 11 km west of Kraków in southern Poland, is the largest regional airport in the country. 7.9 million people live within 100 km of the airport.

TRANSPORTATION

There are several ways to get to The DoubleTree by Hilton Krakow:

1. Line 33200 train
2. Line 5 tram
3. Taxi: Prices vary between \$8-\$40 USD, Airport is located approximately 20 miles from the hotel.

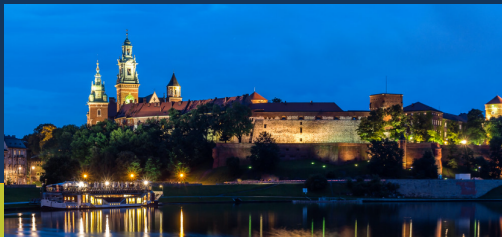




RESEARCH PRESENTATIONS

The following oral research report will be presented Monday morning of the conference. Only RR2023-3 will be represented.

RR2023-3: Creep behavior under small deviatoric stress will present the project results by a research team led by Institut für Gebirgsmechanik. The work will highlight a review of existing studies (creep mechanisms, influence of microstructures, creep tests on rock salt), the modeling of creep at low stress (review of constitutive models, benchmark simulation), and provide recommendations for a potential lab test program.



FUTURE CONFERENCES

Fall 2024 | **22-25 Sept**
Edmonton, Canada

Spring 2025 | **27-30 April**
Wilhelmshaven, Germany

Fall 2025 | **28 Sept -1 Oct**
Wichita, Kansas, USA

Spring 2026 | **To Be Determined**
Location: TBD

SPRING 2024 SPONSORS

Sponsorships help defray costs of hosting conferences, keep conference fees affordable, and allow more of the member dues to be directed towards active research. Members or non-members may be sponsors. SMRI's 2024 sponsorship information is available online or you may contact Dawn Langlinais or Jennifer Looft for more information. No commercial advertising will be accepted, but SMRI will acknowledge contributions of all sponsors.

Thank you to our sponsors of the Spring 2024 Krakow, Poland, Conference!

DIAMOND



GOLD



SILVER



BRONZE



CONFERENCE APP SPONSOR





TECHNICAL CLASS

Technical Aspects and Considerations for Cavern Abandonment

SUNDAY, APRIL 21 | 8 AM – 5 PM

The Technical Class, typically held on Sunday prior to the Technical Session, is designed to be an introductory course or refresher course for the variety of disciplines and management levels that work in the solution mining environment and with solution mined caverns. Hydrogen Cavern Storage Considerations was chosen as the topic for the Technical Class for Fall 2023 and Spring 2024 based on a survey by SMRI leadership to members.

With the current focus on energy security and efforts to reduce dependence on natural gas around the globe, energy companies and governments are racing to develop their hydrogen storage capacities. Although Natural gas storage caverns have been widely implemented for decades and much evaluation and literature has been developed concerning this, large scale development of hydrogen storage in salt caverns has been limited, but it has been proven feasible and safe. This class will help provide some of the answers needed

to understand the peculiarities and similarities of hydrogen as compared to natural gas storage in caverns.

The SMRI has continued to be a leader in the mining and storage industry with many research projects and technical presentations over the past years. Of particular interest to attendees should be the recent completion of SMRI Research Report RR2023-1: Hydrogen Storage in Salt Caverns, Current Status and Potential Future Research Topics. The report provides an excellent overview with focus below:

- Status of research on hydrogen storage in salt caverns
- Identify current status of the cavern industry's knowledge
- Consideration of recently ongoing research projects
- Identify technical gaps
- Identification of potential research topics, bases for developing RFPs

To provide further insight into these concepts, the SMRI has proposed a

technical class registration fees

MEMBERS
\$400

MEMBER REGULATOR
\$150

NON-MEMBERS
\$650

**NON-MEMBER
REGULATORS***
\$400

STUDENTS
(SUBJECT TO SPACE)
*No Charge

tentative list of topics for the
Technical Class including:

- Overview of Hydrogen; Chemical/ physical properties
- Overview of Business drivers for Hydrogen Storage
- Case histories of existing/ planned projects
- Relevant considerations for geology, rock mechanics, & thermodynamic modeling
- Material considerations in hydrogen applications
- Regulatory considerations and testing

The SMRI does include in the schedule of the Technical Class sufficient time for questions and open discussion during the sessions. Additionally, the structure of the session breaks and lunch breaks are great opportunities to continue the discussion with cavern peers.



ICE BREAKER

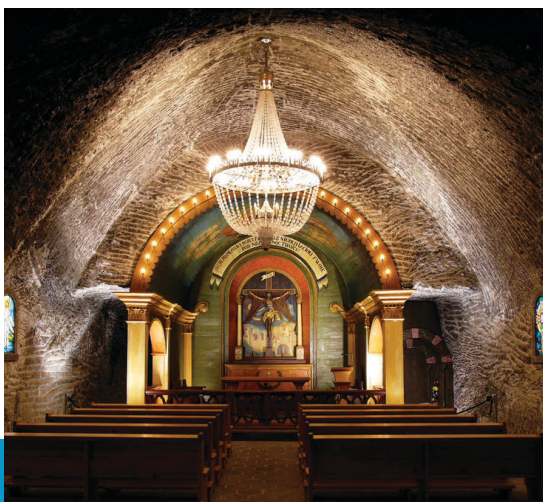
Sunday, April 21 | 6:30 - 8:30 pm

Join SMRI friends for appetizers, wine, beer, coffee, tea, and soft drinks. It's a great way to kick off the Spring 2024 Krakow Conference. No charge for delegates. \$50 fee for guests.

MONDAY NIGHT EVENT

\$150/person | Max. 225 guests

Join SMRI participants and guests to travel to the Wieliczka Salt Mine for an amazing journey, replete of huge galleries, salt sculptures, old machines, medieval mining tools, and emerald colored salt wells. Participants will be picked up at the hotel in large buses. Once at the mine, you will meet up with your official tour guide for a group visit. The passage for tourists only includes the first three levels. After the walk-through, the group will meet in The Warszawa Chamber, an underground event space for dinner, drinks, and a musical treat. Load buses at 5:45 PM. Return about 11:30 PM.



FRIENDS & SPOUSES

Old Town Tour: Krakow Likes to Be Walked

Monday, April 22 - 10am-1pm

If you are here for a quick visit, this tour includes all you need to see to legitimately say that you have been to Krakow. Are you staying in Krakow for a couple of days? Perfect! After our visit to the Old Town you will have all the background you need for a better experience in the city: you will have a good understanding of the turbulent history of Poland and you will know where to find the biggest pork chops, softest dumplings and chocolate vodka :) *15 persons max. \$65.00 per person.*

Jewish Krakow: Past & Present with Schindler's Factory Tour

Tuesday, April 23 - 10am-2:30pm

As we delve into the heart of Kazimierz, often described as a "former" or "historic" Jewish quarter, you'll find that this neighborhood's rich past is intertwined with its vibrant present. You'll be surrounded by the old buildings that once housed synagogues, prayer houses, and townhouses. These structures hold secrets and stories, echoing with the voices of generations past.

Kazimierz is more than just a repository of history; it's a living testament to the resilience and vitality of the Jewish spirit. Thanks to the active Jewish community that thrives here today, you'll discover how ancient biblical traditions are not just preserved but actively continued in the 21st century.

To complete this immersive experience, we'll visit the Schindler's Factory Museum. This poignant stop offers a deeper understanding of the Holocaust's impact on the Jewish community in Krakow and the heroic efforts of those who sought to save lives during one of history's darkest chapters. *15 persons max. \$65.00 per person.*



WEDNESDAY TECHNICAL FIELD TRIPS

FIELD TRIP 1

Wieliczka/Wawel

MAX CAPACITY: 50 (*register early*)

COST: \$150 (*all inclusive of transportation from hotel to mine and museum, guided tours, lunch*)

ANTICIPATED TIME: 8:00 am – 5:00 pm.

The Wieliczka Salt Mine, near Kraków, produced sodium chloride continuously from the 13th century until 1996. Due to falling salt prices and mine flooding, commercial salt mining was discontinued and is now an official Polish Historic Monument and a UNESCO World Heritage Site. Its attractors include the shafts and labyrinth passageways, displays of historic salt-mining technology, an underground lake, four chapels and numerous statues carved by miners out of the rock salt as well as more recent sculptures by contemporary artists. About 1.2 million people visit the Wieliczka Salt Mine annually.

The tour will be guided by the mine's Geological Department, covering geological and mining aspects. The route connects with the Tourist Route, Mining Route, and Museum of Krakow Salt Works. It explores the geological profile, halite crystallization, evaporate sedimentation, salt tectonics, and mining methods from the 19th and 20th centuries. Due to the low and narrow passages, ladder ascents, and steep stairs, the route is not recommended for individuals with claustrophobia or mobility issues.

After lunch, the group returns to Krakow to visit the Wawel Royal Castle. Situated on the left bank of the Vistula River, it's considered Poland's most significant historical and cultural site. The castle, established on the orders of King Casimir III the Great, is part of a fortified architectural complex erected atop a limestone outcrop on the left bank of the Vistula River, at an altitude of 228 metres above sea level. The complex consists of numerous buildings of great historical and national importance, including the Wawel Cathedral where Polish monarchs were crowned and buried. Some of Wawel's oldest stone buildings can be traced back to 970 AD. The current castle was built in the 14th century and expanded over the next centuries. In 1978 Wawel was declared the first World Heritage Site as part of the Historic Centre of Kraków.

Wawel Castle is one of Poland's premier art museums. Established in 1930, the museum encompasses ten curatorial departments responsible for collections of paintings, including an important collection of Italian Renaissance paintings, prints, sculpture, textiles, among them the Sigismund II Augustus tapestry collection, goldsmith's work, arms and armor, ceramics, Meissen porcelain, and period furniture. The museum's holdings in oriental art include the largest collection of Ottoman tents in Europe. About 1.8 million visited Wawel in 2022.

FIELD TRIP 2

Bochnia Salt Mine

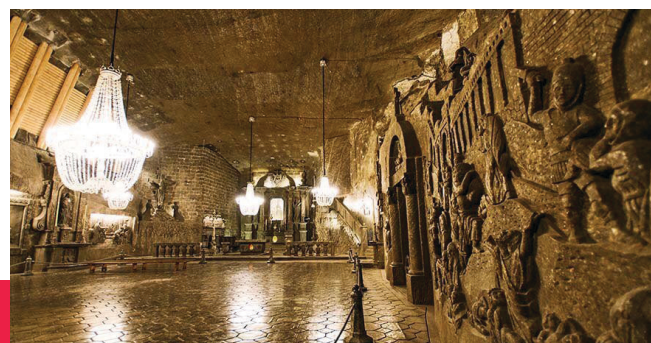
MAX CAPACITY: 45

COST: \$150 (*all inclusive of transportation from hotel to mine, guided tours, lunch*)

ANTICIPATED TIME: 7:00 am – 5:00 pm, but may return late depending on traffic, so please plan accordingly.

The Bochnia Salt Mine in Bochnia, Poland, is one of the oldest salt mines in the world and is the oldest commercial company in Poland. The mine was established in 1248 after salt had been discovered there in the 12th and 13th centuries, and became part of the royal mining company.

In 1990, the mine ceased producing salt but remains a tourist attraction. The mine shafts measure 4.5 km (2.8 mi) in length at about 330–468 m (1,083–1,535 ft) in depth below the surface, at 16 levels. In 1981, it was declared a heritage monument and is one of Poland's official national Historic Monuments. In 2013, the mine was added to the UNESCO World Heritage List as an extension of the Wieliczka Salt Mine inscription of 1978. The group will see the mine on different guided tour routes including the old mining areas and the ferry crossing. The Old Mountains Expedition allows to discover the oldest Bochnia mine workings, which have rarely before been made available to visitors, where rock salt was mined from the Middle Ages to the early 20th century. Further the world's only ferry crossing of an underground chamber flooded with brine is without a doubt the biggest attraction of the Bochnia mine. visitors cross the distance of 120 m in chamber flooded with brine, accompanied by two raftsmen, who spin colourful tales of the mysterious recesses of the Bochnia mine. Completing the route requires good physical condition. Due to the low and narrow passages, ladder ascents, and steep stairs, the route is not recommended for individuals with claustrophobia or mobility issues.





TECHNICAL PAPER LIST WITH ALL AUTHORS

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Author(s)	Organization(s)	Title
Nicole Dopffel ¹ , Katerina Cerna ² , Biwen Annie An-Stepec, Petra Bombach, Kenneth Wunch, Alsu Valiakhmetova, Tzvetanka Boiadjieva-Scherzer, Bjorn Berseth, Joachim Tremosa, Delpine Rogers	Norwegian Research Center NORCE ⁽¹⁾ Technical University of Liberec ⁽²⁾	Microbial Risks Associated With Hydrogen Underground Storage in Europe - HyLife Project
Yigitcan Akyuz, Faruk Suluki, Baris Kandemir, Arda Ozturk	Kazan Soda Elektrik Uretim Co.	Improving the Ore Extraction Ratio in Solution Mining
Kazimierz Urbanczyk	Ubroservice	Controversies Over the Leaching Rate and Other Factors Affecting Cavern Development in a Salt Deposit
Scyller J. Borglum ¹ , Mahya Hatambeigi ¹ , Katie Kellogg ¹ , Timothy Masterlark ³ , Sophie Minas ² , Maria Pacheco ¹ , Nils Skaug ¹	WSP ¹ RESPEC ² SD Mines, Universal Exports LLC ³	Earthquake Hazards for Salt Caverns Caught in the Convergence of Tectonic Plates
Tianjie Pan, Karl-Heinz Lux, Ralf Wolters-Zhao	Clausthal University of Technology	Laboratory Investigations on the Mechanical Properties and Gas Tightness of Wellbore Cements and Casting-Cementation-Rock Salt Composite Systems for Salt Caverns
Katarzyna Cyran, Tomasz Tobola, Pawel Kaminski	AGH University of Sciences	Laboratory Experiments on Microscale Deformation Mechanisms of Rock Salt
James Cornell ¹ , Humberto J. Machado ² , Gustavo A. Ariza Gonzalez ²	5E-Advanced Materials ⁽¹⁾ Weatherford International ⁽²⁾	Changing Mindsets: How O&G ALS technology Concepts Enable Worldwide Food Security and a Greener Future by Improving Boron Production Efficiency in a Mining Application Project Developed in California
Wilkoj P. ¹ , Derdowski R. ¹ , Szmanda,J. ¹ Cicha-Szot R. ² , Lesniak,G. ²	Gas Storage Poland SP. z o. o. ⁽¹⁾ Oil and Gas Institute - National Research Institute (INiG) ⁽²⁾	Laboratory Studies of Salt Rocks to Assess the Feasibility of Large-Scale Hydrogen Storage in Salt Caverns
Romy Smit ¹ , Naomi van Ameele ² ³ , Annemarie Muntendam-Bos ² ³ , Heijn van Gent ³ , Elmer Ruigrok ¹ ⁴ , Jesper Spetzler ⁴ , Hadi Hajibeygi ²	Utrecht University ⁽¹⁾ Technical University Delft ⁽²⁾ State Supervision of Mines ⁽³⁾ Royal Netherlands Meteorological Institute (KNMI) ⁽⁴⁾	Re-Assessment of Micro-Seismicity in the Heiligerlee Salt Dome
Sandro John	K-UTEC Salt Technologies	A New Geophysical Method to Better Image the Steep Flanks of Salt Diapirs



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Author(s)	Organization(s)	Title
Eduardo Cazeneuve ¹ , Yasmina Bouzida ¹ , Nora Alarcon ¹ , Mort Houston ¹ , Karim Sabaa ¹ , Kurt M. Loeff ²	Baker Hughes ⁽¹⁾ United Brine Service Company ⁽²⁾	A Novel 3D Reservoir Characterization to Help De-risk a Complex, Highly-Deformed Salt Structure with Limited Subsurface Data at Saltville, Virginia
Katarzyna Gurdak	AGH University of Krakow	Storage Potential of Permian Zubers – a Review
Pierre Martin ¹ , Laurent Boufflers ¹ , Sebastien Dugaz ¹ , Patrick Roordink ² , Justine Bernard ³	Vallourec One R&D ⁽¹⁾ N. V. Nederlandse Gasunie ⁽²⁾ Vallourec New Energies ⁽³⁾	OCTG Connections Evaluation for Underground Hydrogen Storage
Heijn van Gent, Gerco Hoedeman, Elisenda Bakker	SSM, Ministry of Economic Affairs and Climate Policy, the Netherlands	The Abandonment of Large Caverns and Underground Hydrogen Storage in Salt – Views and Lessons from a Mining Authority
Eric Fortier ¹ , JM Embry ¹ , Richard R. Bakker ² , Els Wijermars ²	Baker Hughes ⁽¹⁾ Nobian Industrial Chemicals B.V. ⁽²⁾	Detailed Microseismic Monitoring Improvement by a High Resolution Field Specific Velocity Model – Salt Caverns of a Nobian Site in Netherland
Markus Knauth, Christoph Luedeling, Ralf-Michael Guenther	IfG Institut fur Gebirgsmechanik GmbH	Rock Salt: Hydraulic Integrity and Creep for Safe and Efficient Cavern Operations
Stefan Kurzelt ¹ , Sabine Donadei ² , Carsten Reekers ² , Eddy Kuperus ³	DEEP.KBB ⁽¹⁾ Storag Etzel ⁽²⁾ Gasunie ⁽³⁾	H2 Cavern Storage Transition (H2CAST) Etzel – Conversion of Existing Caverns for Hydrogen Storage
Joyce Schmatz ¹ , Mingze Jiang ¹ , Jop Klaver ¹ , Marinus den Hartogh ² , Richard Bakker ² , Johannes Herrmann ³ , Christopher Rolke ³ , Dirk Naumann ³	Microstructure and Pores GmbH ⁽¹⁾ Nobian Industrial Chemicals B.V ⁽²⁾ IfG- Institut fur Gebirgsmechanik GmbH ⁽³⁾	Microstructural Investigation of Heterogeneous Rock Salt Permeation: Unraveling the influence of Anhydrite and Mega-Grain content on Fluid Transport
Christopher McMichael ¹ , Andy Moffat ¹ , Silvan Hoth ² , Jamie Slingsby ³	AtkinsRéalis ⁽¹⁾ Equinor ⁽²⁾ SSE ⁽³⁾	Technology Readiness Assessment of Equipment Required to Support the Development and Operation of Subsurface Hydrogen Storage Facilities in UK and Europe
Sebastian Boor ¹ , M. Strzeja ¹ , Juergen Kepplinger ² , N. Weber ²	Uniper Energy Storage GmbH ⁽¹⁾ DEEP.KBB GmbH ⁽²⁾	Hydrogen Pilot Cavern Krummhörn, Demonstration of a Hydrogen Storage Solution
Brett Covey	Quest Integrity	Improved Integrity Solutions on the Casing Well Barrier Element through Enhanced Technology Resolution and Data Analytics



TECHNICAL CLASS SCHEDULE

Time	Instructor	Title	Objectives
8:00	Class Introduction: Tim Bauer, <i>SMRI Research Coordinator</i>		
8:10	Olaf Kruk <i>Socon</i>	Overview Hydrogen Gas	Understanding Hydrogen, properties, safety considerations and detection, similarities to and differentiation from Natural Gas for Storage
8:35	Don Conley <i>Sandia</i>	Hydrogen Industry/governmental drivers/regulatory issues (North America Perspective)	Understand the drivers for the hydrogen push and specific business drivers and regulatory environment. (Gov. incentives, hydrogen hubs, overview/outlook for current/future projects)
9:00	Yvan Charnavel <i>Storengy</i>	Hydrogen Industry/governmental drivers/regulatory issues (European/other Perspective)	Understand the drivers for the hydrogen push and specific business drivers and regulatory environment. (Gov. incentives, hydrogen hubs, overview/outlook for current/future projects)
9:25	Sophie Minas <i>WSP</i>	ACES Project	Overview of Hydrogen Project in progress in UTAH
9:45	Patrick J.P. Roordink <i>Gasunie</i> Gregoire Hevin <i>Storengy</i>	Projects A8 HyStock and HyPSTER: Two pilot experiments of Hydrogen Storage in Salt Caverns	Overview of pilot of hydrogen storage in a salt cavern
10:05	BREAK: Coffee/Tea, Refreshments (30 Mins)		
10:25	Paul Munsterman <i>LINDE</i>	LINDE Moss Bluff H2 Cavern	Overview of and lessons from Existing Cavern
10:45	Kurt Loof <i>Texas Brine</i> Anna Lord <i>Sandia</i>	Geological Considerations for Hydrogen Caverns	Potential geological influences for hydrogen vs nat gas service
11:05	Sam Voegeli (S.A.) <i>RESPEC</i> Dirk Zapf (Kr) <i>IUB</i>	Geomechanical Considerations for Hydrogen Service	Potential geomechanical considerations for hydrogen vs nat gas service
11:25	Joel Nieland <i>RESPEC</i> Benoit Brouard <i>Brouard</i>	Cavern Operations/ Thermodynamics	Modeling of cavern thermodynamics, gas nominations (Differentiation from Natural Gas) Software examples
12:00	LUNCH BREAK: Included with Class Registration (1 Hour)		
13:15	Hippolyte Djzanna <i>INERIS</i>	Blowout Modeling	The modeling of the subterranean and aerial parts of a blowout from a hydrogen storage cavern.
13:50	Brennan Domec <i>Expro</i>	Casing and welding concerns	Considerations for casing specifications, material, welding for hydrogen service.
14:20	Barry Roberts <i>Sandia</i>	Sealing (Cement, Elastomers, Threaded connections)	Overview of current status of cementing technologies, elastomer concerns and suitable material selections, threaded connections.
14:50	BREAK: Coffee/Tea, Refreshments (30 Mins)		
15:15	Brandon Lampe <i>Agapito</i> Rene Schneider <i>DEEPKBB GmbH</i>	Regulations (North America/Europe)	Overview of regulations for Hydrogen caverns, including safety requirements
15:35	Joel Warneke <i>CSI</i> Amaud Revellere <i>Geostock</i>	Completions/conversions/MIT (North American /European Perspective)	North American/European typical completions, MIT considerations, regulatory considerations (Plus microbial considerations[CSI]).
16:25	Heike Bernhardt <i>DEEPKBB GmbH</i>	Repurpose of Existing Caverns	Evaluation of deciding factors for repurposing existing caverns for hydrogen service.
16:50	Questions/Discussion		
17:05	Concluding Remarks: Tim Bauer, <i>SMRI Research Coordinator</i>		