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Short communication

Bridging knowledge between unsaturated geomechanics and energy geotechnics

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ABSTRACT

The crucial interaction between lessons learned from the study of unsaturated soil mechanics and energy geotechnics was highlighted at the recent third edition of the International Symposium on Energy Geotechnics (SEG23), held in Delft, the Netherlands. This short communication summarises the discussion that revolved around handling the many issues raised by the current energy transition from fossil fuels to more sustainable and renewable resources, and the need to integrate unsaturated soil knowledge into energy geotechnics. The panel discussion at the symposium emphasised how crucial it is to use the fundamental concepts of unsaturated soil mechanics for a range of energy applications to be able to characterise key underlying multi-phase processes and enable efficient design. With representatives from around the world, the panel discussion's goal was to close the gap between theoretical research and real-world applications by fostering a dialogue between academics and industry, thereby advancing creative and sustainable geotechnical solutions. The understandings generated from this conversation highlighted the necessity of ongoing cooperation and knowledge sharing to propel area developments and successfully address the urgent energy and environmental challenges of our time.

1. SEG23: International Symposium on Energy Geotechnics

Between the 2nd and the 6th of October 2023, the third edition of the International Symposium on Energy Geotechnics (SEG23) was celebrated in Delft, the Netherlands. This is one of the flagship events for one of the Technical Committees of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), with a focus on energy, environment and their intersection with geotechnics.

The symposium is organised every four years, and the 2023 edition was made possible thanks to the fantastic efforts of an engaged and active local organising committee comprising representatives from both industry and academia and across a range of related expertise. The organisation of the event took place within a relatively short timeframe after the pandemic had significantly slowed down cross-border, in-person interactions for more than two years, without sacrificing quality and spread of reach. This was a significant achievement thanks to the Dutch local organising committee, for which the energy geotechnics community has shown due appreciation. The local organising committee comprised members from academia, national research organisations and industry, and received support from an international scientific

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committee, giving the symposium the cross-sector flavour that further transpired into the Panel Discussion.

The record five day meetup included a welcome reception on the night of the 2nd of October, five Keynote Lectures by established world technical authorities on various energy geotechnics subject matters, two Bright Spark Lectures by rising stars Drs Benjamin Cerfontaine and Melis Sutman, a number of parallel sessions on topics ranging from shallow and deep geothermal energy, offshore geotechnics, multi-physics experimental testing and modelling, reservoir characterisation, to disposal of radioactive waste, carbon sequestration and accounting, gas hydrates sediment behaviour and exploitation, and low-carbon geotechnics. The symposium culminated with two technical visits on the 6th of October. It was a feast of knowledge, sharing and networking for more than 200 attendees.

The symposium also included a new feature on its first day of technical knowledge sharing, an open *panel discussion* about the role of fundamental knowledge of unsaturated geomechanics on various applications of geomechanics for energy and the environment. This short communication summarises and reports on this distinctive feature of the SEG23.

2. A need for an open discussion

The integration of unsaturated soil mechanics into energy geotechnics may be critical in many applications, and is needed for several reasons, including i) deriving enhanced predictive models, particularly when the ground undergoes cyclic wetting and drying, temperature fluctuations and frozen conditions, and varying stress and fluid pressure conditions, common in energy storage and extraction technologies; ii) finding and refining sustainable energy solutions, for example when optimising geothermal energy systems and the stability of underground energy storage facilities; and iii) improving the characterisation and management of risk, for example when bringing energy solutions into the urban environment or when deciding construction of multi-million dollar resource extraction works. Here we provide an overview of the work undertaken by the Technical Committees of the Soil Mechanics and Geotechnical Engineering (ISSMGE) and introduce the panel that provoked the discussion during the SEG23.

2.1. Technical committees of the international society

The International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) is the preeminent professional body representing more than 20,000 engineers, academics and contractors in geotechnical engineering from around the world. The society cares for their interests, activities and concerns, and has active participation in more than 90 countries and national societies.

To advance with its mission and aims, the ISSMGE have various international committees, such as *Innovation and Development*, *Technical Oversight*, and *Geo-Engineers without Borders*. The Technical Oversight Committee manages the activities of 38 international Technical Committees, where over 1000 individual members are directly involved. Each Technical Committee focuses on a specialist area of geotechnics of current and future interest to the geo-community, meaning that from time to time new committees develop, and some matured ones are retired; these fluxes are driven by needs and emerging trends arisen by the society members themselves.

Technical Committees (TCs) are grouped under three main categories:

- Fundamentals (7 TCs),
- Applications (22 TCs), and
- Impact on society (9 TCs)

The SEG23 was organised on behalf and under the auspices of *Technical Committee 308 on "Energy Geotechnics"*, which falls under the "impact on society" category listed above. However, TC308 has been intrinsically linked to other committees, and to the other end of this spectrum, the more "fundamental" *Technical Committee 106 on "Unsaturated Soils"*.

2.2. Unsaturated geomechanics and energy geotechnics: why this pair?

The symposium focused on "accelerating the energy transition" since most agree that some of the key challenges for the 21st century are managing energy resources and moving towards cleaner sources of energy. It is essential for the geotechnics community to support technically this reduction of carbon emissions and footprint.

The energy transition, however, is likely to last decades, thus making an overnight change impossible if the world is to sustain and satisfy current energy demand, and, in addition, supply the (extra) energy required to actually develop, design and construct the new and emerging green and/or more efficient energy-related technologies. The growth of new technologies does require additional energy during the transition period, so that efficiencies can be realised once these are well established. Fossil fuels are in the foreseeable future still part of this energy transition. Site characterisation, engineering, design, operation and exploitation are still needed for the years to come; and involvement of geo-professionals will continue to be important and relevant, while developing greener geo-technologies and supporting others like wind, solar, hydrogen and nuclear.

A number of energy geo-technologies (TC 308) deal with unsaturated soils or with multi-phase systems (i.e., presence of menisci) where fundamental unsaturated geomechanics knowledge (TC 106) applies. This is precisely why the inaugural open *panel discussion* was organised as a joint initiative from both ISSMGE Technical Committees as a plenary session during the SEG23, with support from the local organising committee.

Anecdotally, the very first event of the TC 308 on Energy Geotechnics, SEG-2015, took place at an iconic location for TC 106 Unsaturated Soils, Barcelona (Spain), one of the birthplaces and nurturing grounds of unsaturated soil mechanics. Many of the participants were indeed original members of TC 106, seeing the applications of some of their more fundamental knowledge in energy (Fig. 1).

2.3. Provoking a conversation: the panel

The first day of the technical program of the symposium featured a "*Panel discussion: TC106 (Unsaturated soils) and TC308 (Energy Geotechnics)*". The intent was to provoke a wider conversation that started with industry and academia views, and to establish an international perspective on the role of unsaturated geomechanics on energy

Fig. 1. First International Symposium on Energy Geotechnics (SEG-2015), celebrated in Barcelona (Universitat Politècnica de Catalunya, Spain) between the 1st and 3rd of June 2015. Rooted in unsaturated soil mechanics, energy geotechnics was emerging as a channel for impact on society.

geotechnics (Fig. 2).

Panellists were intentionally selected to represent the above diversity of opinions, experiences and to answer a series of questions designed to raise awareness among symposium delegates about the work of both Technical Committees, to provide some examples of interactions, and to help start a conversation with the audience. This was gradually achieved, and engagement peaked towards the end of the session, with the cross-over between industry and academia on these topics sparking the most vivid dialogue.

3. Summary of the guided discussion

To get started, a series of questions were directed at the panellists. The first few were intended to be informative to the delegates, but as the session evolved, more thought-provoking and elucidating questions were discussed. Here, we summarise some of these conversations.

3.1. TC 106 Unsaturated Soils: what it is and how it interacts with other TCs

The Technical Committee 106, whose official name is "Unsaturated Soils" falls under the category of "fundamentals" (recall Section 2.1) and counts approximately 90 members from over 40 countries. The main objectives of the committee are to: i) disseminate knowledge and practice (organise/sponsor specialty conferences, symposiums and workshops, etc.), ii) establish guidelines and technical recommendations (codes of practice), iii) interact with industry and overlapping organisations, and iv) cooperate actively with other technical committees whose field of activity involves important questions related to unsaturated soils.

One key aspect of standing before the entire symposium cohort is to start breaking stereotypes about the scope of the TC. For instance, unsaturated soils (soils with a water deficit, either partially saturated or saturated) are often perceived as being relevant only for dams, embankments, and environmental geotechnics, typically focusing on capillarity. While these have been the origins of this long-dated committee, established in 1995 and integrating the past committees on Expansive Soils and Arid Soils, both scope and applications have significantly evolved (an updated summary of current applications is reported in[1]).

Furthermore, the connections between TC 106 Unsaturated Soils and many others within the ISSMGE have increased over the years (see Fig. 3), and is closely aligned with many of the engineering applications and emerging technologies of TC 308 Energy Geotechnics. While this joint panel discussion with TC 308 is opening the conversation with this community, the TC 106 has embarked on similar endeavours with others, as highlighted by the organisation of the: i) mini-symposium on unsaturated soil monitoring at the 7th International Conference on Geotechnical and Geophysical Site Characterisation (with TC 102), 18–21 June 2024, Barcelona (Spain), and ii) pre-conference Workshop of XVIII ECSMGE Lisbon 2024 (26–30 August 2024), on the theme "Bringing together TCs linked to unsaturated soils".

Fig. 2. The panel at the SEG23 event (from left to right): Jose Alvarellos (Repsol), Anne-Catherine Dieudonné (Delft University of Technology), Enrique Romero (Universitat Politècnica de Catalunya), Guillermo A. Narsilio (University of Melbourne – 4EE Pty Ltd, Moderator), Farimah Masrouri (University of Lorraine), and Vincenzo De Gennaro (SLB New Energy Carbon Solutions).

3.2. TC 308 Energy Geotechnics: what it is and what sort of topics it covers

The Technical Committee 308, known as "Energy Geotechnics" was coined shortly after the 18th International Conference on Soil Mechanics and Geotechnical Engineering celebrated in Paris (France), in September 2013, and belongs to the "impact on society" category of the TCs of the ISSMGE (recall Section 2.1).

The TC 308 has approximately 80 members from over 45 countries. The main objectives of the committee are similar to those of TC 106. They further expand in also promoting benchmark exercises to establish the capabilities of current theoretical frameworks and prediction methodologies in the area of *energy geotechnics*, compiling case studies and publications, and creating teaching materials relevant to the subject. These materials are part of current geotechnical courses shared online to foster education and interest in *energy geotechnics*. For example, the ISSMGE Interactive Technical Talks covered topics such as "Geomechanics and Geotechnical Engineering for Nuclear Waste Disposal",[2] and "Energy-Geostructures and Storage of Thermal Energy in the Ground".[3]

This technical committee includes a series of technical and of professional task forces to further focus efforts on distinct aspects of energy geotechnics (Fig. 4). "Fundamentals of geo-energy", "Radioactive waste disposal" and "CO_2 geological storage" are the more obvious closely aligned TC 308 task forces to TC 106 unsaturated soil mechanics. However, the intersection does not stop just there, and the professional task force on "Academia-Industry partnership for innovation" has proven during the panel discussion at SEG23 to be another strong area in much need of collaboration between technical committees.

3.3. Necessary interactions between TC 106 (unsaturated soil mechanics) and TC 308 (energy geotechnics)

Both Technical Committees share the objectives of promoting new cross-disciplinary and inter-sectorial collaborations with other TCs. During the SEG23 session, the panel was also asked to start listing engineering problems in the energy sector that involve knowledge of unsaturated geomechanics. Some of the answers are summarised below:

Compacted engineered barriers (seals/backfills). These are used to protect the environment in the energy sector (this can apply to landfill design in some cases as well), for example, for high-level heat-emitting radioactive waste, involving partially saturated geomaterials and thermo-hydro-mechanical (THM) processes, lasting for periods of times many fold longer than typical geotechnical engineering projects.

Gas in soils and rocks. Soils and sediments that produce and/or collect gaseous substances fall inherently under the study of unsaturated geomechanics given the presence of gas phase, commonly alongside a liquid phase in the matrix. Gas storage and transport are critical to energy geotechnics, for example with applications on CO_2 sequestration and "green" gas geological storage, including trending topics on hydrogen. The presence of two-phase fluid flow(s) and the drying/degradation of rocks and their mechanical stability are coupled physics, where lessons from unsaturated soil mechanics are apparently relevant and largely transferrable.

Thermo-active elements in contact with partially saturated

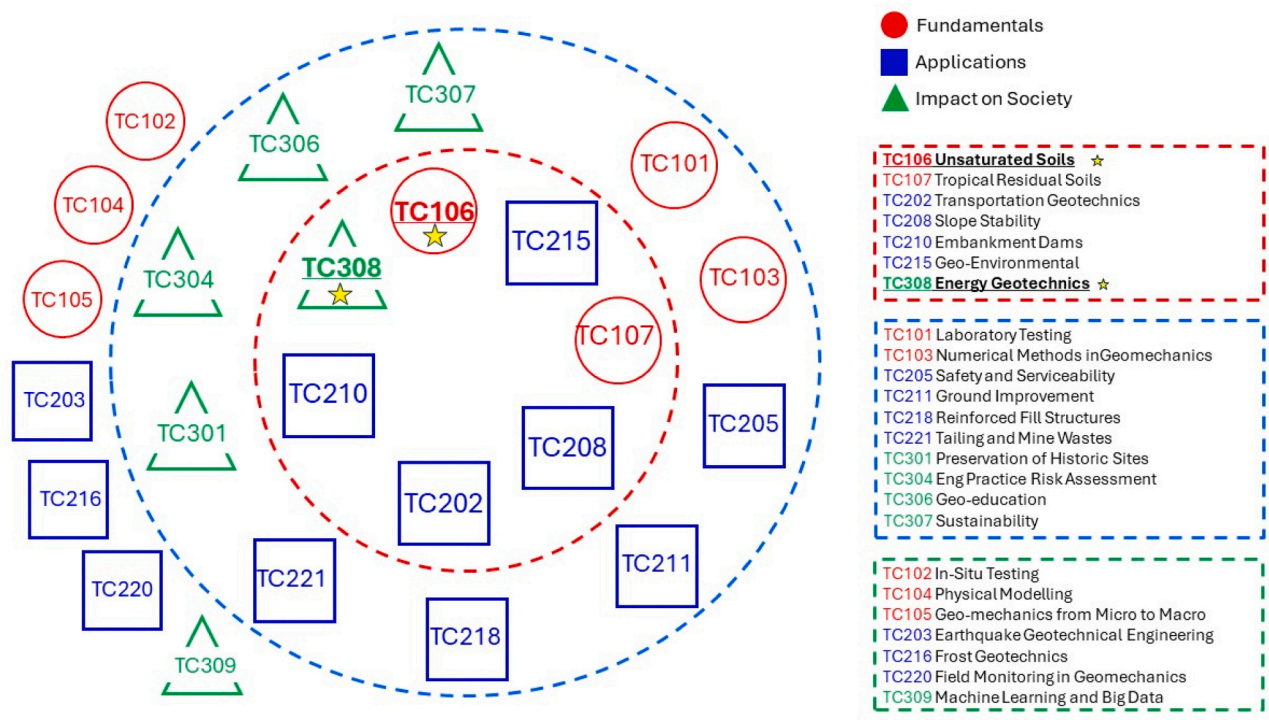

Fig. 3. Cooperations between TC 106 and other TCs whose fields involve questions relevant to unsaturated soil mechanics and beyond (perspective of cooperations just before SEG2023). TCs within the red dotted line area are those of more immediate co-dependency and stronger cooperations forged over the years. TC308 arises as the only "Impact on society" type of TC of cooperation with TC106.

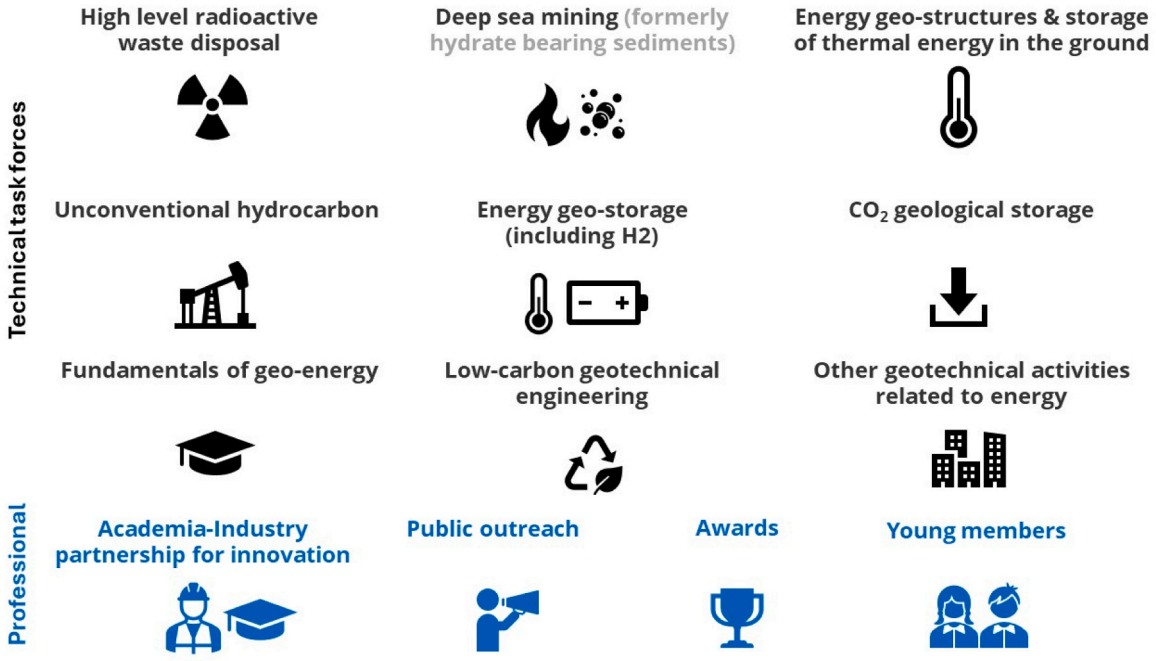

Fig. 4. TC 308 Energy Geotechnics technical and professional task forces for concentrated efforts, activities that drive the committee agenda.

ground and interfaces. Recognising that a temperature field affects soil water content, and that thermal conductivity depends on the hydraulic state, made some of the audience realised that in ground source heat pump systems, thermal storage and other problems with sustained or cyclic ground temperature changes, although apparently small cycles (i.e., not as extreme as in deep geothermal, oil & gas or radioactive waste disposal problems), can impact soil/rock behaviour due to the underlying THM processes familiar to unsaturated geomechanics.

Carbon sequestration in unsaturated soils under "low-carbon geotechnical engineering" perspectives. For example, unsaturated soil knowledge is critically important in "engineered" vegetated soils and to account for ground-atmosphere interactions.

During the discussion, it became evident that **flow of immiscible liquids** – specifically, the invasion and receding of different liquids,

even in "saturated media" – plays a crucial role in oil and gas energy geotechnics applications. There is a need to view these problem through the eyes and lessons learned from the menisci system that arise from more traditional soil-water-air systems in "unsaturated soils mechanics".

4. Examples of unsaturated knowledge use in energy geotechnics

We include next some further discussions given by panellists and audience in the use of unsaturated geomechanics knowledge in energy geotechnics. While the examples given are far from exhaustive, they serve to provoke new considerations when approaching engineering projects in the energy sector, both in the pursuit of innovation and research and development, as well as in the delivery of commercial projects.

4.1. Deep geological repository for radioactive waste

A good example presented by the panellists included a compacted engineered seal for a future deep geological repository for low and intermediate-level (L/ILW) radioactive waste. This seal will experience long-term saturation and subsequent gas generation and transport, primarily due to the degradation of organic materials and corrosion of metallic canisters. Two methods for gas dissipation are usually considered: i) allowing it to slowly diffuse through the pore water in a saturated seal that has a high gas breakthrough pressure and ii) permitting the gas to pass through at low breakthrough pressure by using a gas-permeable seal. The example mentioned pertains to the latter case and presents a good context to interpret multiphase (liquid and gas) motion in porous materials to support field tests required to expand our capability to predict the response of unsaturated porous media in energy geotechnics applications.

Within this context, a demonstration test was implemented in the Grimsel Test Site (Gas-Permeable Seal Test GAST[4,5]). As shown in Fig. 5-a, the GAST core is composed of a dynamically compacted 80/20 % sand/bentonite (S/B) mixture in layers, which limits the gas breakthrough pressure and increases the gas transport capacity through advective flow while maintaining a low water permeability, an essential feature for preserving repository integrity. Laboratory results with flow parallel to the S/B compaction layers showed maximum breakthrough pressures suitable for a gas permeable seal, with magnitudes consistent with the gas-entry value measured in element tests.[6,7] At a smaller scale, Fig. 5-b illustrates a schematic of gas penetration in voids between sand grains filled with low-density bentonite. At the sand-bentonite interface, the low swelling pressure of the bentonite controls the gas penetration capability of the system, leading to a reduced gas breakthrough pressure.

4.2. Geothermal structures and thermal storage: THM behaviour of the soil and the soil-structure interface

Ground source heat pump or shallow geothermal systems use elements that are in intimate contact with the ground to exchange heat with it throughout the year. A heat pump then uses this harnessed heat and upgrades it to provide space heating and cooling (and domestic hot water) to nearby buildings or industrial processes. The heat exchange is realised via open or closed loops. In a closed loop system like the one schematically shown in Fig. 6, vertical boreholes, horizontal trenching (and ponds) or geostructures are used as ground heat exchangers.[8,9]

In GSHP systems, forced temperature variations typically ranging 0–40 °C over the year, may induce complex thermo-hydro-mechanical loading effects on the nearby ground and the soil interface zone (Fig. 7-a). These can affect both short- and long-term response.

In the Linzer tunnel in Vienne and the Gecko Project in France, for example, saturated and unsaturated soil-structure interface for both thermo-mechanical monotonic and cyclic tests were undertaken.[11] Microscopic observations were also used to provide further insight into the shear mechanism at the interface. This allows the provision experimental data on *unsaturated* soils for calibration of coupled models. In addition, non-isothermal interface models have been proposed for cyclic thermo-mechanical loads.[12] The use of unsaturated soil mechanics in this case is apparent.

Depending on how the GHSP system is operated, or alternatively, on the way the ground heat exchangers are placed and, in some cases, enchased on thermally insulated packs, thermal storage in soils is possible over seasons. A particular example of this energy geotechnics use related to unsaturated soils was presented for the case of embankments, where horizontally placed ground heat exchangers near their base are placed (Fig. 7-b). Clearly, to optimise *thermal efficiency* of the system, one must understand the thermo-hydraulic transfer occurring within typically unsaturated soils, and how the positioning of the exchanger loops may affect moisture variations and consequently permeability, soil heat capacity and thermal conductivity. On the other hand, the *mechanical performance*, in terms of consolidation and settlement, shear characteristics, and even creep behaviour, may be affected to varying degrees. Here, once again, the THM coupling requires a broad

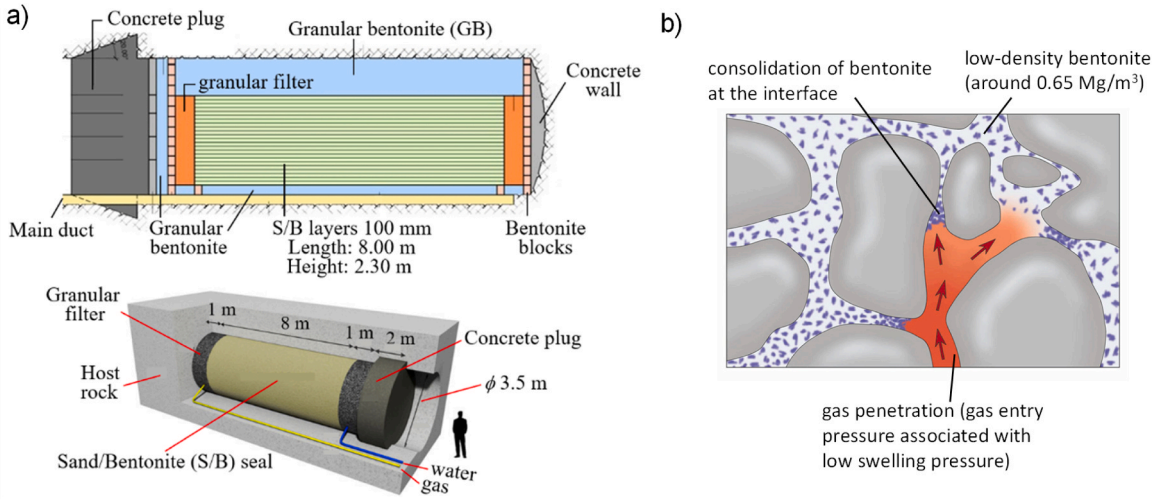

Fig. 5. Engineered gas permeable sand/bentonite S/B seal for a deep geological repository of low and intermediate-level (L/ILW) radioactive waste. a) Schematics of the in situ GAST experiment showing the compaction layers of the S/B seal. b) Schematic of gas transport mechanism in S/B (a) (modified from[4,5]). (b) (modified from[6]).

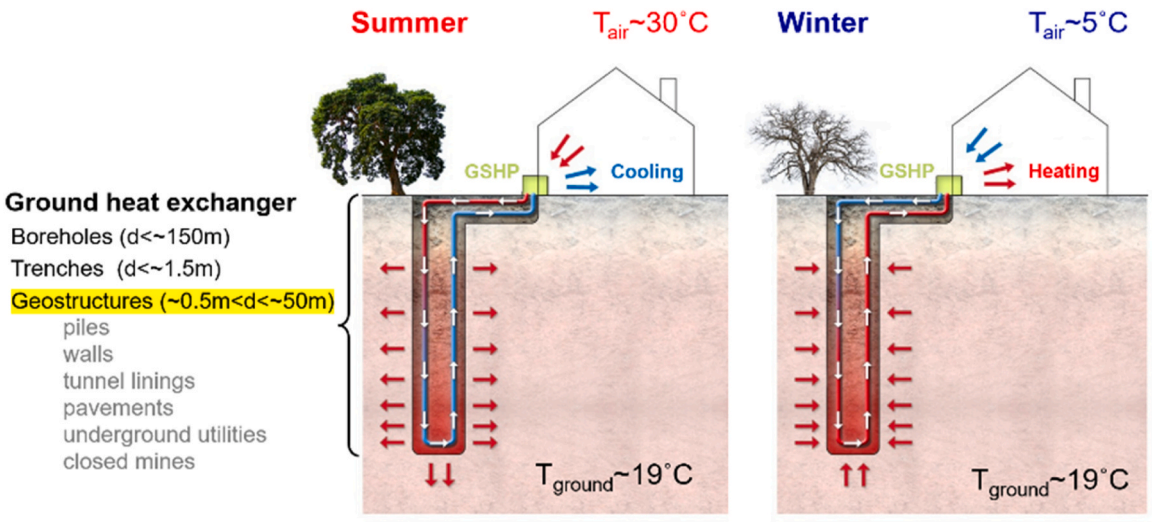

Fig. 6. A ground source heat pump (GSHP) system in a temperature climate site (hinted by the ground temperature T_{ground} at 19 °C), showing different options for used and trialled ground heat exchangers (GHEs)
(modified from [10]).

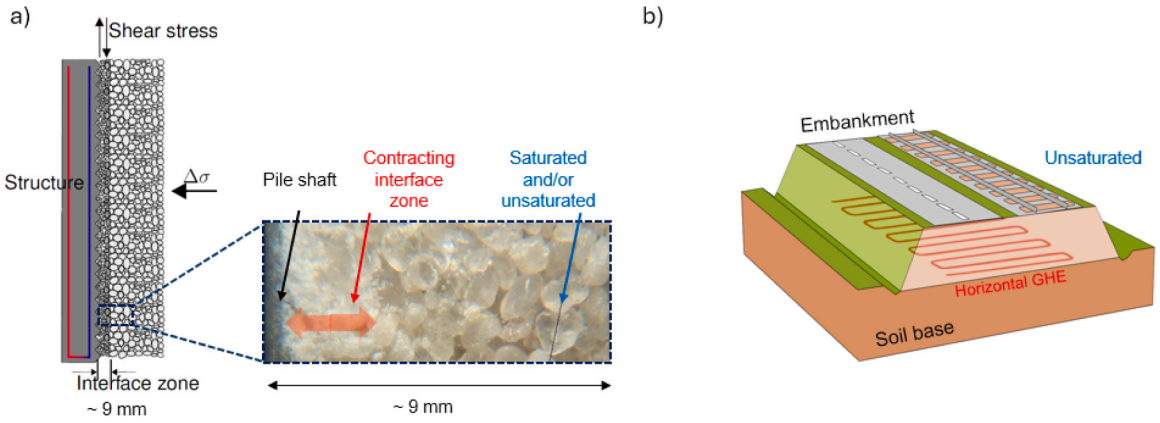

Fig. 7. Energy geostructures and thermal storage examples: a) thermo-activated retaining wall (i.e., an energy geo-structure) and the thermo-hydraulic-mechanical response of the immediate interface and retained soil, and b) thermal storage on an embankment using horizontal ground heat exchangers.
a) (interface detail modified from [13]).

understanding of thermal, hydraulic and mechanical processes in unsaturated compacted soils. It is worth noting that in energy geostructures, which tend to be closer to surface, i.e., higher chances of unsaturated conditions, unsaturated geomechanics become important.

5. Fundamental & applied research and the industry needs

Over the final portion of the discussion, we debated how industry and academia can better interact through applied research. Furthermore, panellists exchanged views on how much academia knows about actual industry needs and their working methods.

A focal point of the conversation was around multi-physics numerical modelling and the fidelity levels of such models used in practice. A full fidelity numerical model for fracture propagating in a deep geological hydrocarbon reservoir was showcased. As shown in Fig. 8, even under "saturated" conditions (i.e., degree of saturation close to one as pores are filled with liquids), the presence of immiscible liquids prompts to use the lessons learnt from unsaturated soils and, in particular, the coupling of thermo-hydro-mechanical processes in simulations, the deep understanding of multiphase (liquid and gas) flow, and of complex constitutive laws for fracture energy and propagation, aside from the length (and temporal) scale of the problem and code architecture and hardware required to handle such application.

Extensive and non-standard testing is required to calibrate the various laws and models, and collaborations across teams intra- and inter-institutional are needed to achieve these objectives. Here collaborations with other organisations including universities and institutes are critical, particularly for the development of the overall modelling concepts and to bring non-standard specialist testing to industry.

Accounting for changes in stresses due to reservoir depletion, and the effect of pore pressure on the minimum horizontal stresses during injection, which affects fracture propagation for production, only adds complexity to the system. Considering the complete natural discontinuities in the reservoir, which must be carefully mapped as well through available site investigations (often largely incomplete), makes the models and simulations more realistic and of high fidelity. Natural fractures can alter manmade fracture propagation. Fig. 9 shows the effect of the orientation (dip) of a natural fracture on such propagation. In natural reservoirs, hundreds and thoughts of discontinuities exist, and multiple interactions emerge. The results of one such example at different time steps of simulations are shown in Fig. 10.

In most cases, practice cannot afford and is quite rare to access high fidelity models. Industry often resorts to faster, simpler, spreadsheets-type models that do not render the realism of high-fidelity models, yet

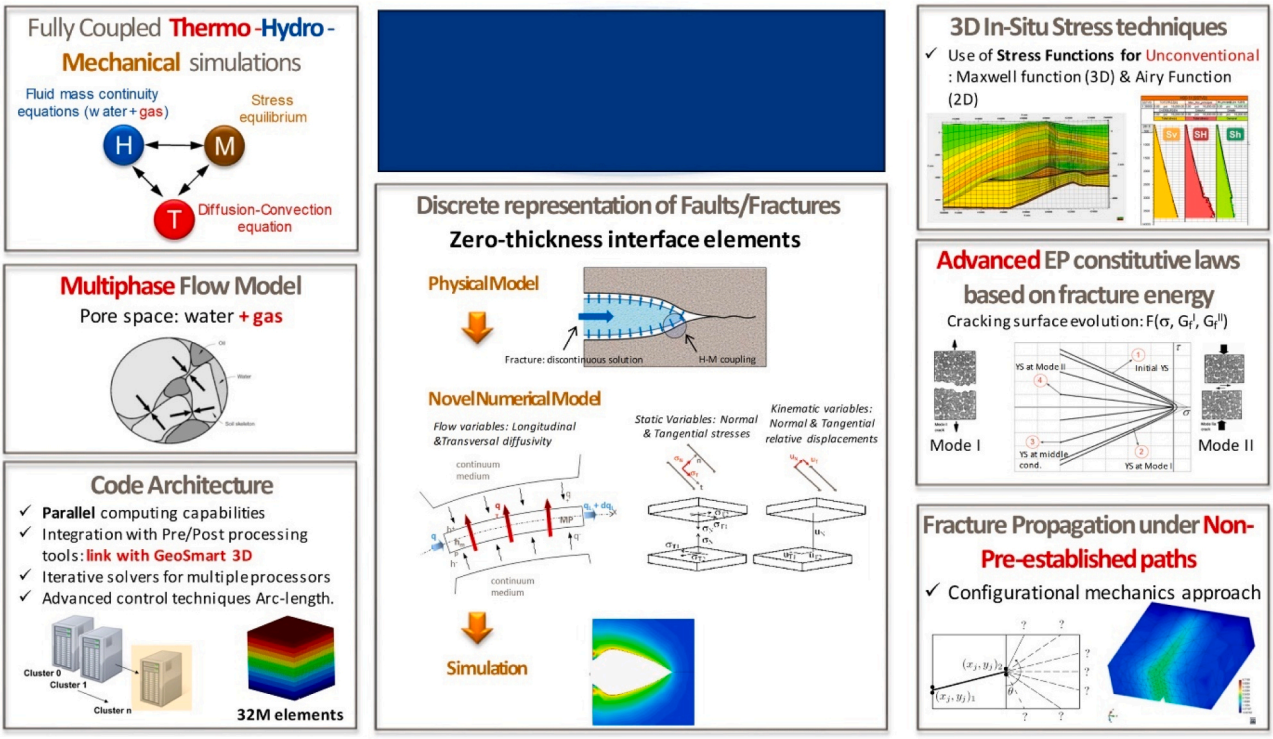

Fig. 8. Components, understanding required and architecture of a multiphysics full fidelity numerical model for fracture propagation on an oil & gas reservoir (image supplied by Repsol).

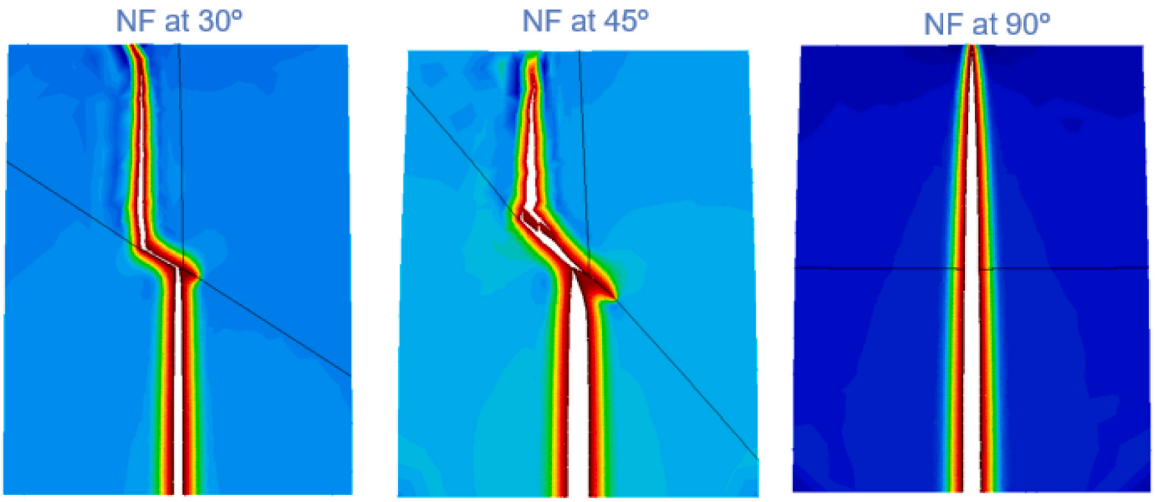

Fig. 9. Fracture propagation and effect of natural fractures (NF) deeping on a relatively simple test case.

cater for the speed and pace of industry decisions. This was highlighted as one significant difference found when working collaboratively between industry and academia.

Academic insight is needed to help determine which processes are important and which can be neglected based on specific industry needs. High fidelity models are highly useful in this process. Accuracy versus speed of results for certain risk profile applications are in the balance.

6. Summary and conclusions: a call for action

This work aimed at documenting the panel discussion session during the latest and third edition of the Symposium on Energy Geotechnics (SEG23). The integration of fundamental knowledge gained over decades in unsaturated soil mechanics into energy geotechnics has proven beneficial and essential for advancing the field and addressing the energy transition required to fulfill local and global carbon emission reduction commitment, the most readily available example being on geological disposal of radioactive waste. SEG23 successfully opened the conversation to a wider audience and, through various examples, seeded the urge for a collaborative environment where experts from academia and industry could discuss and identify key areas where unsaturated soil knowledge significantly impacts energy geotechnics.

One of the key messages from the panel discussion held during the SEG23 was the understanding that many energy geotechnics applications inherently involve multi-phase systems and/or plain unsaturated conditions. For instance, geothermal systems and thermal energy storage solutions rely heavily on understanding the thermo-hydro-mechanical behaviour of the ground and interfaces.

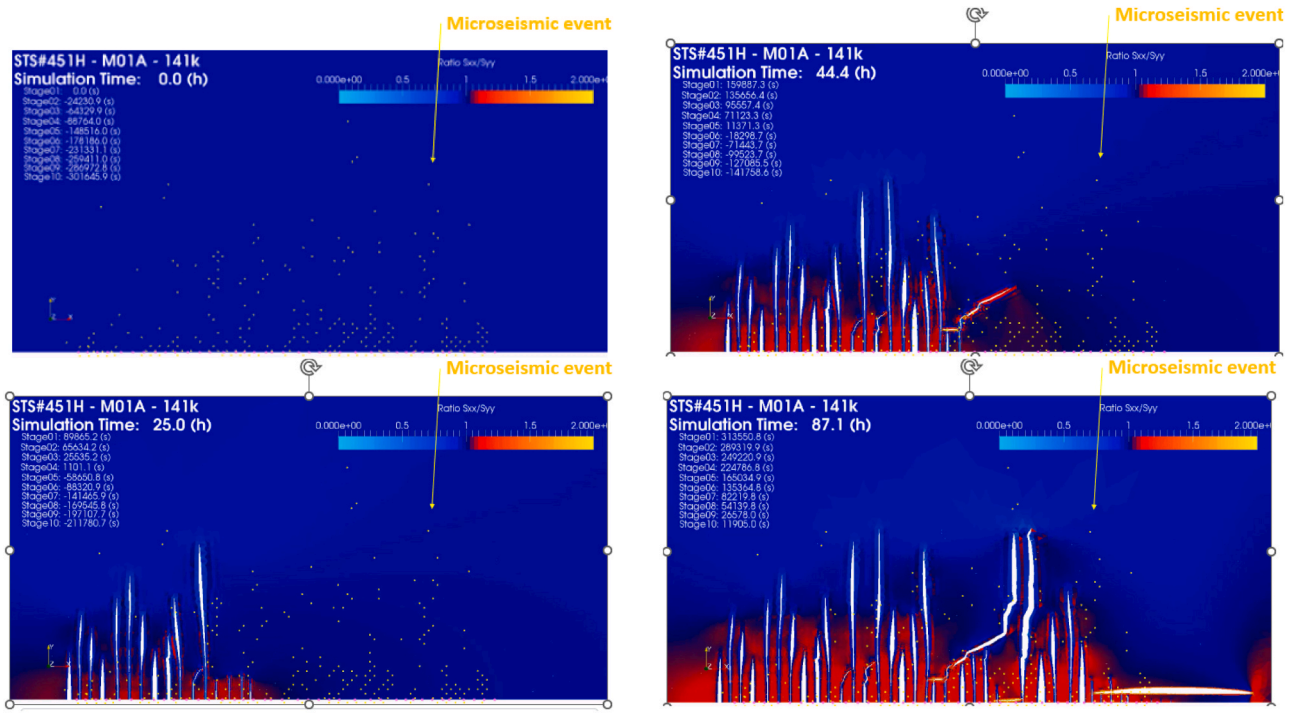

Fig. 10. High fidelity fracture propagation numerical model in a reservoir over 90 h of fluid injection, with multiple natural fractures interacting in the development and propagation of the anthropogenic new fractures. Snapshots at 0, 25, 44 and 87 h are shown.

The discussions also highlighted the importance of unsaturated soil mechanics in the development, design and management of radioactive waste disposal sites. Engineered barriers and seals in these sites must account for gas migration, hydration cycles, and long-term stability, all of which are governed by principles of unsaturated soil behaviour.

The exchange of knowledge and a few examples during the featured panel discussion, and certainly throughout the whole symposium, brought insights on innovative approaches to energy-related challenges, demonstrating how fundamental research can inform practical solutions. Indeed, the panel stressed the critical role of multi-physics numerical modelling in bridging the gap between theory and practice. High-fidelity models that incorporate the complex interactions between mechanical, hydraulic, and thermal processes are needed for designing and optimising energy geotechnics applications. However, there is a pressing need to balance the accuracy of these models with the speed and practicality required by industry, and to balance high site characterisation and computational costs. Collaborative efforts can lead to the development of robust yet practical tools that cater to both academic rigor and industry needs.

In conclusion, the inaugural panel discussion jointly organised by the ISSMGE's Technical Committees 308 on Energy Geotechnics and 106 on Unsaturated Soil Mechanics during the SEG23 symposium was a firm step toward understanding the role and scope of the committees in the global geotechnical community on one hand, an on recognising and hopefully enhancing the synergies between these areas on the other hand. The organisers and panellists aimed at fostering an open dialogue and at encouraging cross-disciplinary collaborations. Overall, the symposium showcased some innovative solutions which can drive the energy transition forward. Continued efforts to integrate these fields will not only advance geotechnical engineering but also contribute significantly to global sustainability goals.

CRediT authorship contribution statement

Dieudonné Anne-Catherine: Writing – review & editing, Resources, Conceptualization. **Narsilio Guillermo Andres:** Writing – original draft, Resources, Methodology, Conceptualization. **Alvarellos Jose:** Writing – review & editing, Visualization, Methodology, Conceptualization. **Romero Morales Enrique E:** Writing – review & editing, Visualization, Conceptualization. **De Gennaro Vincenzo:** Writing – review & editing, Resources, Conceptualization. **Masrouri Farimah:** Writing – review & editing, Visualization, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Authors report financial support and travel were provided by their affiliated institutions and relevant projects. G Narsilio and A-C Dieudonné are guest editors of the special issue hosting this short article. Authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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