SUMMER 2026

Southwest Research Institute®

TECHNOLOGY TODAY®

Using Internal Research and Development funding, Southwest Research Institute is developing techniques to improve inhalers for young children and others with breathing difficulties. Variability with inhalers can be significant and potentially dangerous because overdosing medications can lead to adverse effects, while underdosing can result in ineffective treatment. Combining computational fluid dynamics (CFD) with particle and pharmaceutical sciences, a multidisciplinary team is creating a more effective medicinal inhaler for people who can't manage the strong, deep breaths crucial for maximum benefit from standard designs. Using this 3D-printed model of a child's airway, SwRI is creating and testing new inhaler designs to reduce medication deposition in the mouth and throat and increase particle penetration into deep airways. The goal is to allow weak inhalations from a young child or very sick person to pull enough medicine into the lungs for effective treatment.

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SUMMER 2026 • VOLUME 47, NO. 2

TECHNOLOGY TODAY

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ON THE COVER

As the electric vehicle battery boom drives lithium demand, Southwest Research Institute geologists are studying volcanic-ash-derived clay deposits, which represent a potential domestic U.S. lithium supply.

CONTENTS

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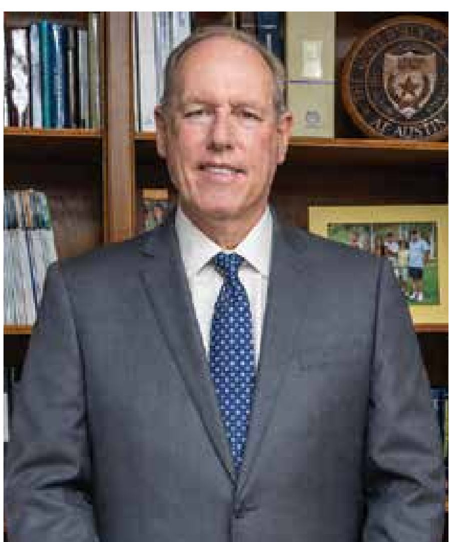


IN THIS ISSUE

While innovation is Southwest Research Institute's superpower, its nonprofit status is what fuels it. Any income from thousands of contract research projects conducted each year is combined and invested in internal projects and Institute facilities, which both serve as incubators for ideas.

SwRI's longstanding Internal Research and Development Program funded the multidisciplinary research project featured on the opposite page. The project aims to improve inhaler designs to allow weak inhalations from a young child or very sick person to pull enough medicine into the lungs for effective treatment.

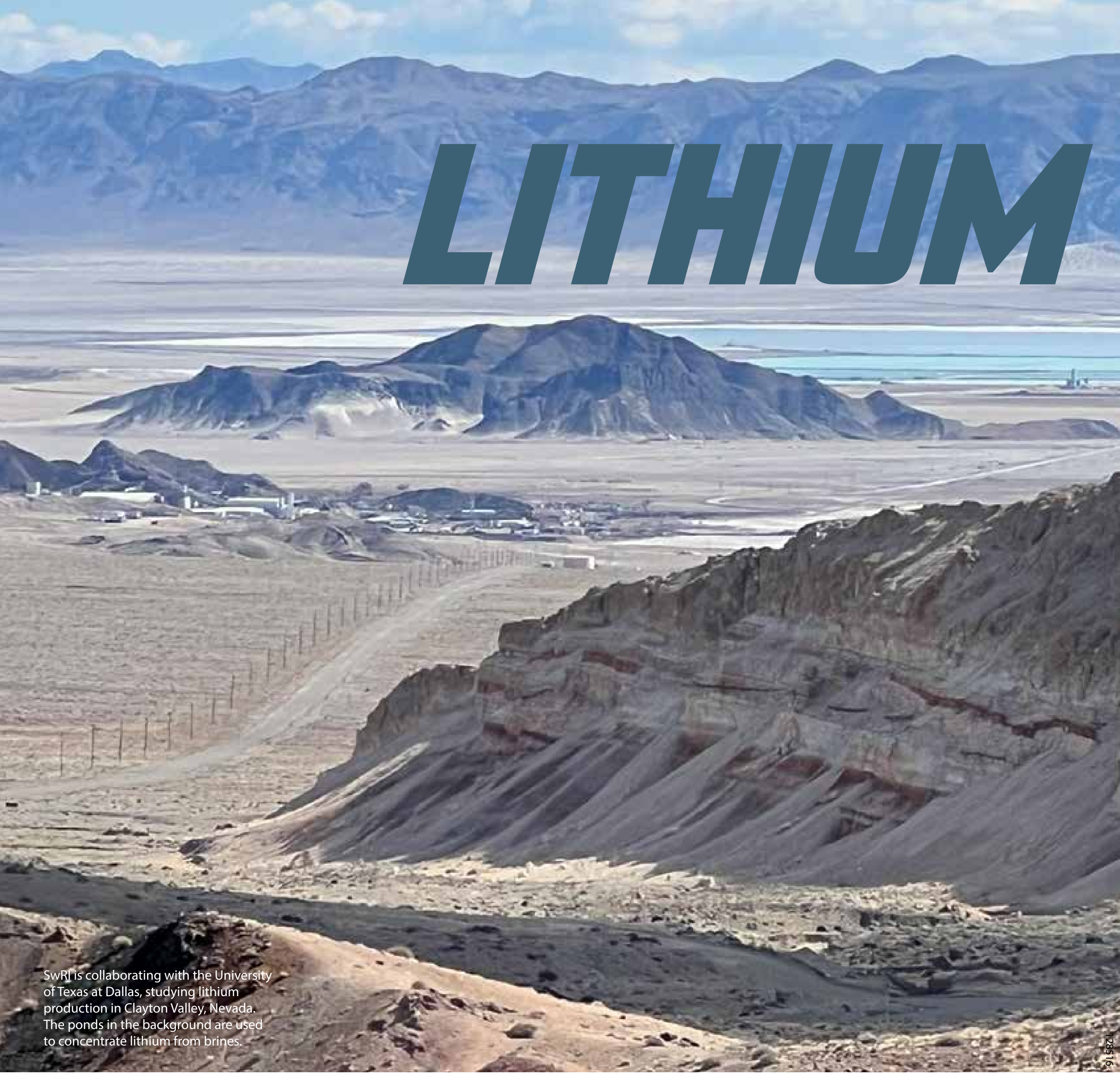
The cover story discusses a geoscience program designed to discover new domestic sources for lithium, conducted with the University of Texas at Dallas. Funded jointly by SwRI and UTD, the Seed Projects for Research, INnovation, and Technology (SPRINT) is one of seven programs designed to encourage collaboration between SwRI and nearby universities. This project focused on understanding the lithium enrichment process to address the burgeoning demand for this crucial material used in batteries for electric cars and personal devices.

The final feature focuses on new and expanded infrastructure powering discoveries in emerging energy technologies. These investments target the intersection of traditional energy infrastructure and tomorrow's advanced power systems — a transition demanding a multidisciplinary approach, leveraging decades of expertise to improve mechanical, aerodynamic and thermodynamic performance.

Read on to learn how SwRI invests in the vital bridge between theoretical innovation and real-world applications, to benefit our clients and, ultimately, humankind.

Dr. Ben H. Thacker, P.E.
Chief Operating Officer

LITHIUM

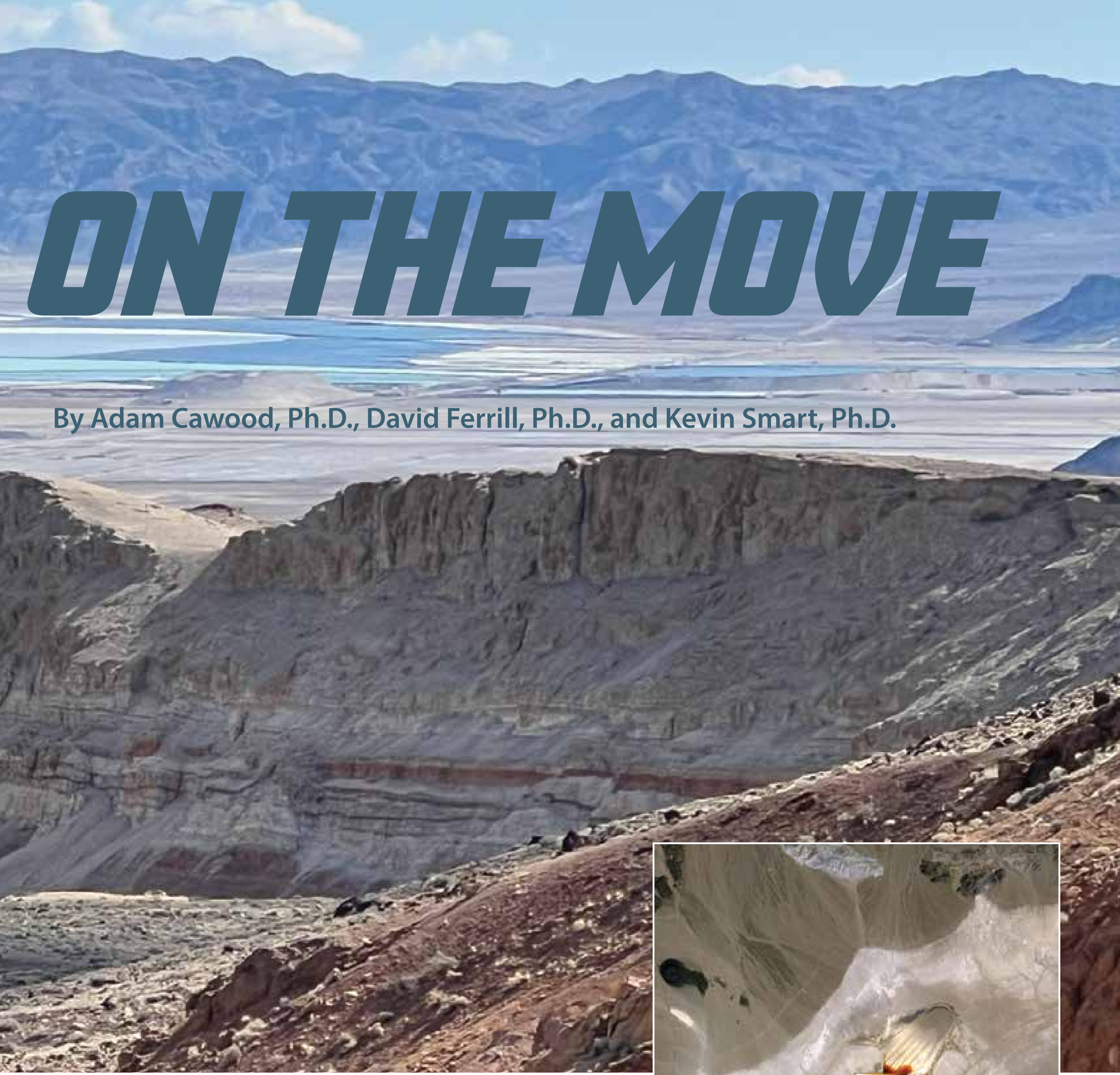


SwRI is collaborating with the University of Texas at Dallas, studying lithium production in Clayton Valley, Nevada. The ponds in the background are used to concentrate lithium from brines.

For most of the 20th century, lithium was not a high-profile resource. Industry used the highly reactive, light metal in relatively small volumes, primarily in glass and ceramics, lubricating greases and medical treatments. Demand was steady but limited, and production reflected that scale. Hard-rock pegmatite, a coarse-crystalline igneous rock often containing high concentrations of lithium minerals, provided initial supplies.

ON THE MOVE

By Adam Cawood, Ph.D., David Ferrill, Ph.D., and Kevin Smart, Ph.D.



By the late 1930s, industry was recovering lithium from brines at Searles Lake, California, as a minor byproduct of large-scale salt and mineral production. A more significant shift occurred in the 1960s with lithium production from subsurface brines in Clayton Valley, Nevada. That operation remains the only active lithium brine production site in the United States today.

Over the past two decades, demand for lithium has increased sharply. The use of lithium-ion batteries to

This 2013 satellite image details the only operating source of lithium in the United States in Clayton Valley, Nevada. Operators pump subsurface salty brines into evaporation ponds so vast that they are visible from space. As the water evaporates, it leaves behind a concentrated lithium-rich mixture of materials.

IMAGE COURTESY NASA/METI/AIST/JAPAN SPACE SYSTEMS & U.S./JAPAN ASTER SCIENCE TEAM

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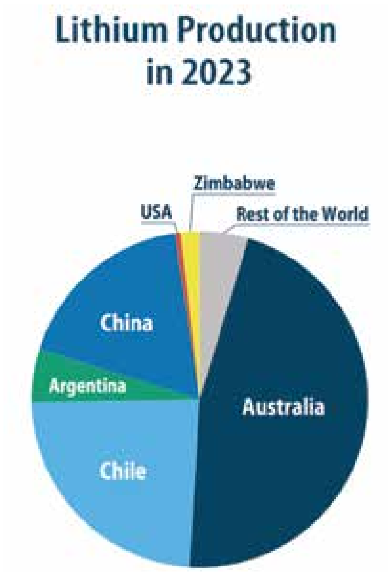
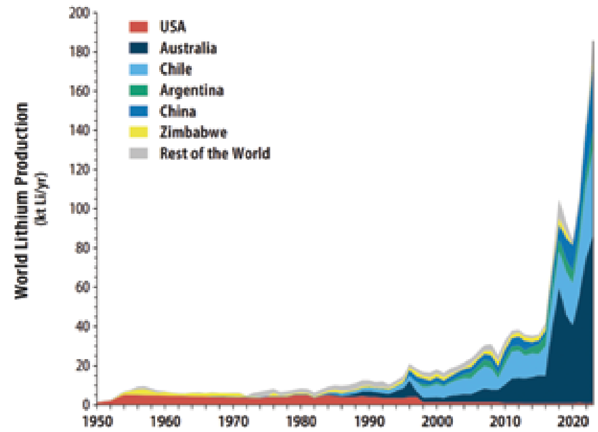
DETAIL

Lithium brines are saline groundwaters enriched in dissolved lithium and other elements. In Clayton Valley, large evaporation ponds concentrate lithium in brine form for chemical processing and extraction.





The United States was once a significant producer of lithium. However, as the demand has increased exponentially since the turn of the century, the U.S. contribution has dwindled. In 2023, Australia, Chile and China produced most of the lithium required for batteries powering personal devices and hybrid and electric cars. *Data source: Energy Institute, Statistical Review of World Energy 2025.*

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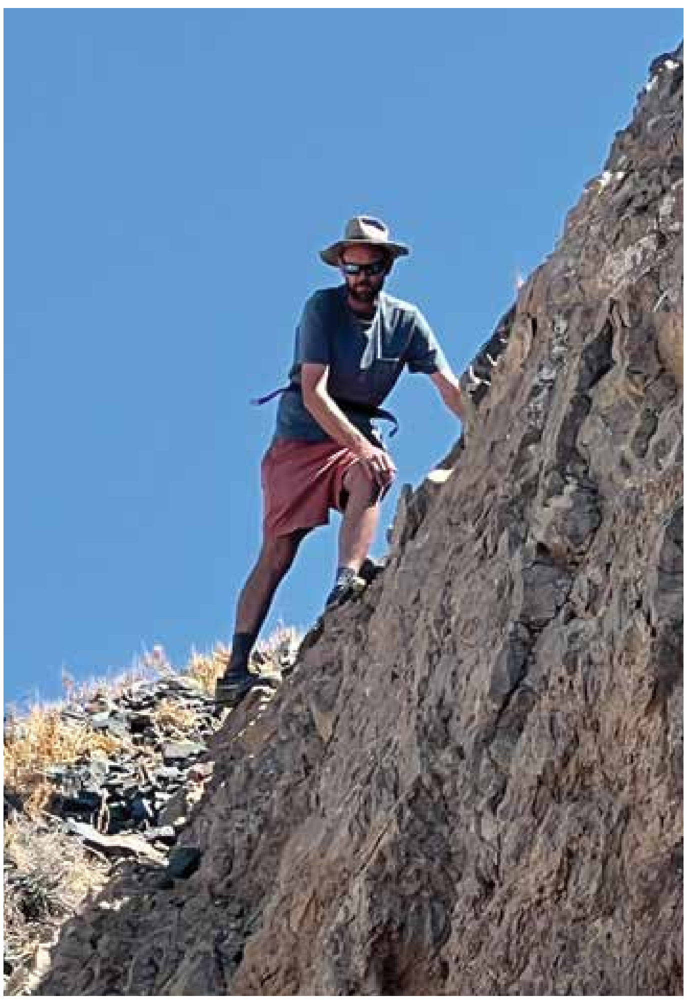

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Dr. Adam Cawood examines faults in Clayton Valley, Nevada, documenting structures that provide a geologic record of fluid flow and lithium transport.

power electric vehicles, grid-scale energy storage and portable electronics has transformed the resource from a niche industrial material into a key component of modern energy systems. Lithium is now widely classified as a critical mineral, with increasing emphasis on securing a reliable domestic supply. Despite this importance, the United States produces only a small fraction of the global lithium supply and relies heavily on imports. Growing demand for lithium is driving renewed interest in understanding how lithium deposits form and how new resources can be identified and developed. Southwest Research Institute is actively working in this area through studies focused on lithium-bearing geologic and hydrologic systems in Clayton Valley, Nevada.

A CRITICAL MINERAL IN SHORT SUPPLY

Lithium is not particularly rare. It is present in Earth's crust at an average concentration of tens of parts per million and occurs in a wide range of rocks, soils and natural waters. At these concentrations, however, lithium is too diluted to be economically extracted.

Recently, lithium exploration has focused on volcano-sedimentary systems, where the element leaches naturally from silicic volcanic rocks into fluids and accumulates in basin sediments. In sediment-hosted and brine systems, lithium is highly mobile, readily leached from source rocks and transported in fluids, allowing it to accumulate and become enriched in groundwater brines, clay minerals and basin sediments.

Formation of economically feasible resources requires not only a lithium source, but also conditions that concentrate and retain it. Hydrologically closed basins with no surface or groundwater outflow, coupled with arid climates that drive evaporative enrichment, are ideal. In contrast, hard-rock lithium deposits form where lithium is concentrated in minerals formed during magmatic and hydrothermal processes, rather than through basin-scale fluid transport and evaporation. For lithium brine deposits, improved exploration success depends on understanding the

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SwRI and UTD researchers studied faults in Paymaster Ridge, a small mountain range in Esmeralda County, Nevada, that defines the eastern margin of Clayton Valley.

controls on lithium mobilization, transport and retention within these systems.

SOURCE TO SINK: PATHWAYS & TRAPS

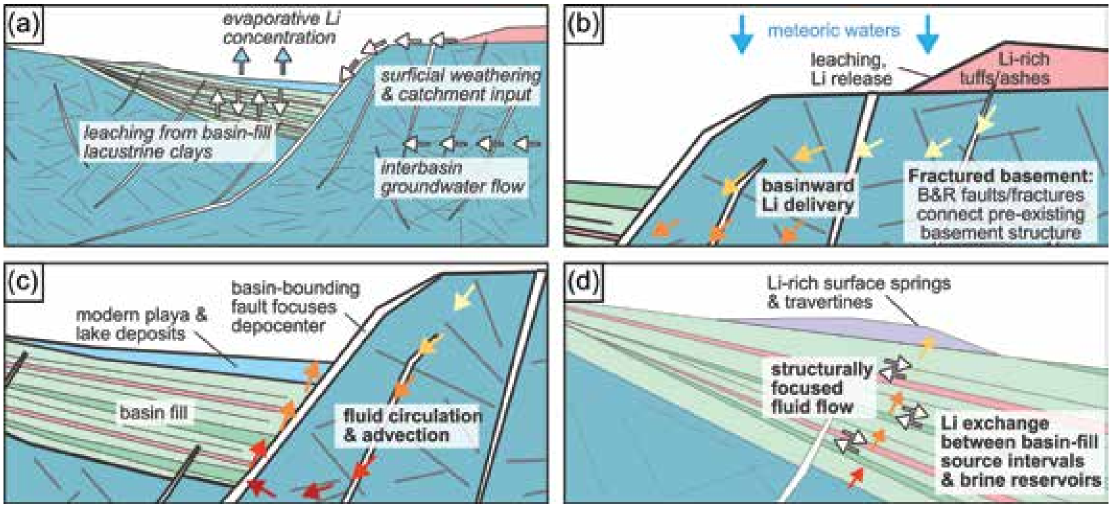
Recognizing that lithium must be both mobilized and trapped shifts the focus from simply identifying source rocks to understanding the natural fluid-movement pathways connecting source to sink. In many basin systems, those pathways are controlled by faults and fractures — structures that can serve as long-term conduits for fluid flow, linking primary lithium sources to present-day deposits.

To better understand how these systems operate, SwRI is collaborating with the University of Texas at Dallas (UTD) through the SwRI-UTD SPRINT program to investigate lithium-bearing geologic and hydrologic systems in Clayton Valley, Nevada.

The basin provides a natural laboratory for studying lithium transport and enrichment. Scientists think lithium is leached from abundant volcanic rocks by weathering and transported into the basin where it accumulates in sediments and brines. While this broad framework is widely accepted, the mechanisms that govern

DETAIL

Some of the research described in this story was funded by The University of Texas at Dallas Office of Research and Innovation and SwRI through the Seed Projects for Research, INnovation, and Technology (SPRINT) grant. SPRINT was developed to encourage collaboration between the two organizations.



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This conceptual model shows how lithium is leached from rocks and transported by surface water associated with precipitation and groundwater (a & b). Lithium is then transported through the subsurface via flow along faults and fractures and concentrated in basin sediments and brines (c & d).

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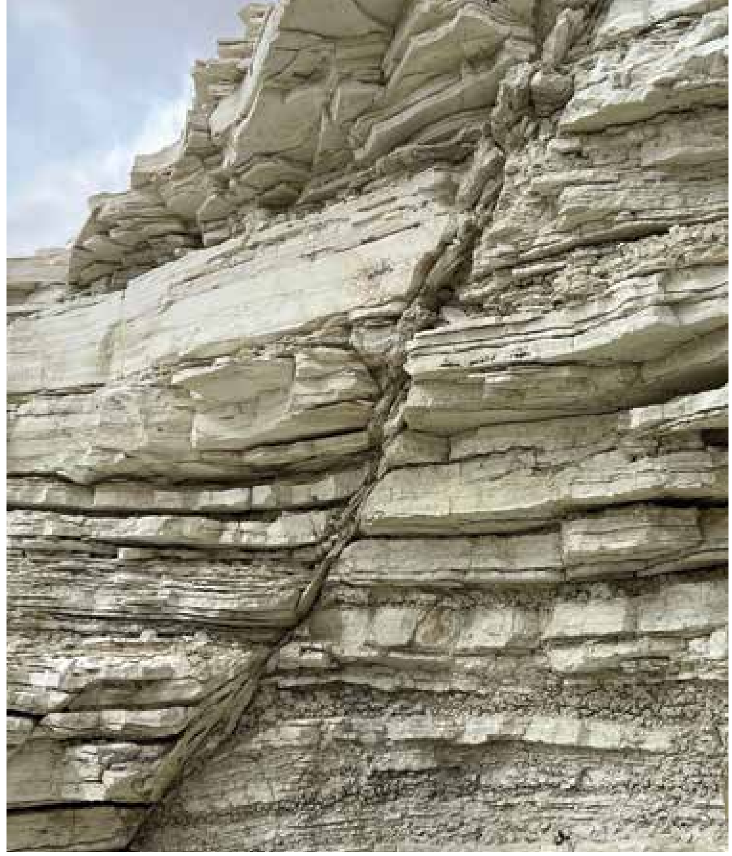
This fossil hot spring deposit in Clayton Valley provides a window into ancient fluid flow systems, a key feature of the dynamic processes involved in lithium mobilization, transport and retention. Hot springs were actively flowing in Clayton Valley through most of the 1900s but were dry by 1980.



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The team studied layered volcanic ash deposits, which weather and, over time, transform into lithium-rich clay minerals, a potential new lithium resource.

lithium transport and concentration remain poorly understood. In particular, it is unclear how fluids move through subsurface bedrock and sedimentary strata over time, how fault and fracture networks evolve and how lithium concentration is retained rather than lost through outflow or dilution.

DETAIL

Photogrammetry uses overlapping photographs and specialized software to reconstruct outcrops and geologic structures as high-resolution 3D models, allowing researchers to map faults, fractures and rock relationships in detail.

LINKING STRUCTURE & FLUID FLOW

To address these questions, SwRI and UTD researchers combined structural geology with geochemical and geochronological techniques to reconstruct fluid flow in Clayton Valley. Field studies focused on mapping faults, fractures and sedimentary units across the basin and surrounding highlands, supported by high-resolution digital data of outcrops generated using drone-based photogrammetry.

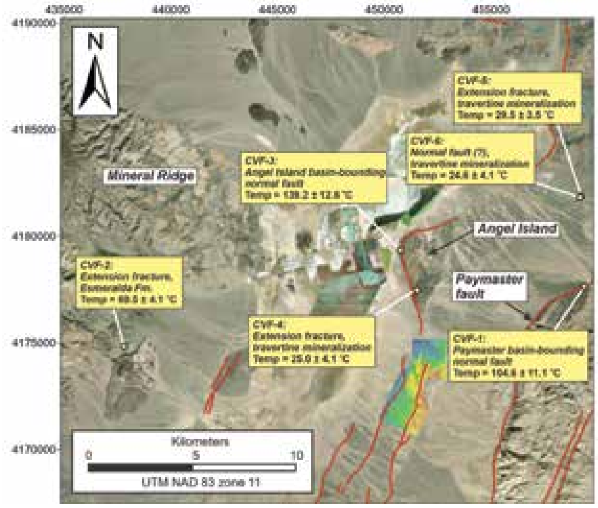
The team collected and analyzed samples from faults, fractures and spring deposits to determine lithium concentrations, mineral compositions, temperatures and mineral formation timing. Based on these datasets, lithium enrichment reflects a combination of processes rather than a single source or event. Lithium is derived in part from volcanic material. Structural and geochemical data indicate that transport by fluids through fault and fracture networks also plays a crucial role. Fluids circulating at depth and moving through the basin over time play a key role in controlling fluid flow and lithium transport.

READING THE RECORD: TIMING & TEMPERATURE

If lithium brine systems are controlled by fluid flow, then understanding when and how those fluids moved becomes critical. But fluids themselves rarely leave a direct record. Instead, that history must be reconstructed from the minerals they leave behind.

In Clayton Valley, carbonate minerals precipitated along faults and fractures provide that record. These minerals form as fluids move through the subsurface, effectively capturing snapshots of fluid flow over time. By analyzing them, it is possible to move beyond static models and begin to reconstruct the evolution of the system across geologic time.

Researchers at SwRI applied a combination of geochronological and geochemical techniques, assessing these carbonates to constrain both the timing and temperature of fluid flow. Uranium-lead dating of calcite provides ages for mineral growth, while clumped-isotope thermometry offers



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SwRI and UTD studied surface and subsurface temperatures that play a significant role in the development of lithium resources.

DETAIL

Uranium-lead dating uses radioactive decay to determine when minerals formed, providing ages for past episodes of fluid flow and associated mineral growth. Clumped-isotope thermometry estimates the temperatures at which carbonate minerals formed by analyzing how carbon and oxygen isotopes are ordered within the mineral structure.

direct estimates of mineral-formation temperature. Together, these approaches allow scientists to track fluid circulation over millions of years. The results point to a persistent, dynamic system.

SwRI and UTD researchers have found that fluid flow in Clayton Valley has not been confined to a single event. Rather, it occurred in multiple phases over geological time, with fluid temperatures ranging from atmospheric conditions to significantly elevated subsurface temperatures at depth. These variations reflect changes in basin evolution, fault activity and fluid sources, highlighting the role of structural pathways in repeatedly focusing fluid flow. Rather than a simple process of lithium being leached once and deposited in a single cycle, data suggest that the system may have been reworked over time, with fluids circulating, interacting with rocks and redistributing lithium both vertically and laterally within the basin.

FLUID FLOW CYCLES

The ability to constrain the timing and conditions of fluid flow provides a critical link between source, transport and accumulation, offering a new way to evaluate how and where lithium could be concentrated in similar systems. The data from Clayton Valley indicate that lithium systems are dynamic and that the element has been mobilized, transported and redistributed through the basin over millions of years. Fault and fracture networks play a central role in this process, providing pathways for fluid movement, connecting different parts of the basin and influencing where lithium is concentrated or dispersed. As geologic structures evolve, they modify the pathways available for fluid flow, leading to repeated cycles of redistribution. Lithium distribution reflects the combined effects of source materials, fluid flow pathways and basin evolution over time. Understanding this behavior is important for identifying where lithium is most likely to accumulate in economically viable concentrations.

WHERE LITHIUM ACCUMULATES

The demand for lithium has changed how geoscientists think about the subsurface. What was once considered a relatively simple resource problem is now understood to involve a more complex set of


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SwRI and UTD researchers conducted field work in Clayton Valley, Nevada, mapping faults, collecting samples and documenting structures, providing a geologic record of fluid flow and lithium transport.

FROM DISCOVERY TO EXTRACTION

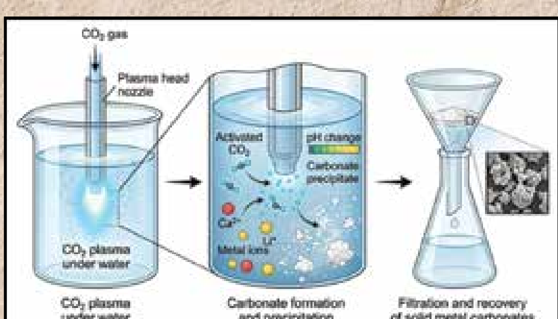
by Josh Mangum, Ph.D., and Vicky Poenitzsch, Ph.D.

In the current environment of high lithium demand, finding the resource is just part of the challenge. Extracting it from clays, sediments and low-grade materials is also difficult. Traditional methods have been optimized for brine or hard-rock deposits, but many emerging resources do not fit these models. Researchers at SwRI are exploring new approaches to lithium extraction, with efforts aimed to complement advances in exploration by expanding the range of lithium resources that can be economically developed.

For instance, materials scientists are developing plasma-based technologies to improve recovery. These involve injecting carbon dioxide gas beneath the surface of a lithium-bearing brine, where a plasma discharge ionizes the gas to generate highly reactive species. The activated CO_2 molecules bond with dissolved metals such as lithium to form metal carbonates. Adjusting the pH of the solution then changes the solubility of the resulting carbonate, causing it to precipitate, which allows the solids to be filtered and recovered. Unlike evaporation-based methods that depend on large surface ponds and long residence times, this process targets dissolved metals directly and operates on much shorter timescales.

SwRI has demonstrated the method using dissolved calcium chloride, which precipitates as calcium carbonate under controlled conditions. Scanning electron microscopy and energy-dispersive X-ray analysis of the recovered material confirm a composition dominated by calcium, carbon and oxygen, consistent with calcium carbonate. These proof-of-concept results provide a foundation for extending the approach to lithium-bearing brines, where selective recovery of lithium carbonate could reduce the land, water and time required by current extraction methods.

As SwRI geologists make advances in exploration, materials scientists are developing the techniques needed to cost-effectively produce the emerging resources.



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This schematic illustrates the plasma-based carbonate precipitation process for lithium production. The technique involves using a plasma nozzle to inject CO_2 ionizing gas below the surface. The activated CO_2 reacts with dissolved metal ions such as lithium or calcium to form carbonates, which are recovered as solid precipitates following pH adjustment and filtration.

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Detailed studies of this normal fault in Clayton Valley, Nevada, are helping researchers understand the complex processes associated with lithium concentration and accumulation. Fault properties vary in response to the movement of the Earth's crust. In the Clayton Valley region the crust has been pulled apart by extensional tectonics. In extended regions, normal faults develop where rock above fault planes moves downward relative to the rock below the fault, stretching and thinning the crust.

processes, where fluid flow, geologic structure and time control where lithium ultimately accumulates. That shift is opening up new opportunities.

Advances in analytical techniques now allow geologists to reconstruct the timing and conditions of fluid flow in ways not possible even a decade ago. These approaches provide a clearer picture of how lithium systems evolve and offer a path toward more targeted and effective exploration. At the same time, the need for lithium is only increasing. Demand driven by electric vehicles, energy storage and the broader transition to low-carbon energy systems shows little sign of slowing.

In the United States, where domestic lithium production remains limited, this adds urgency to efforts to better understand and develop lithium resources at home. Solving that problem requires understanding how lithium moves through the Earth, how it is concentrated and how it is ultimately trapped.

Questions about this article? Contact Dr. Kevin Smart at (210) 522-5859 or kevin.smart@swri.org.

ABOUT THE AUTHORS: From left, **Dr. Kevin Smart** is manager of SwRI's Earth Science Section where he develops projects for a range of clients, with emphasis on oil and gas exploration and production, geothermal energy exploration, groundwater resource analysis and natural hazard assessment. SwRI Technical Advisor **Dr. David Ferrill** is a structural geologist with international research experience in contractional, extensional and strike-slip tectonic regimes, particularly in support of international oil and gas exploration and production. Former staff member **Dr. Adam Cawood** (2020-26), served as a leader of the SwRI-UTD lithium project and made significant contributions to its findings and this article.

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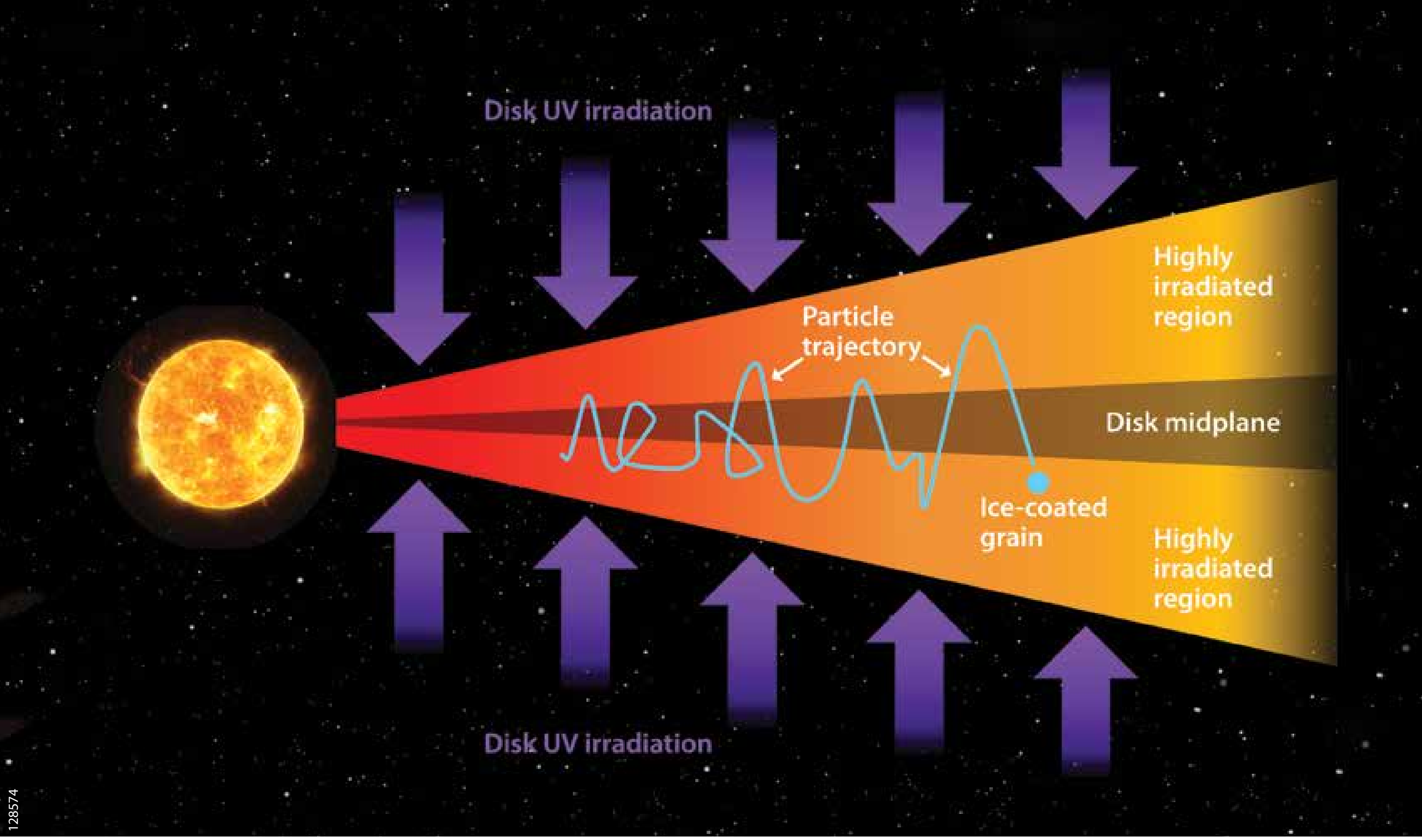
The SwRI-UTD project was funded (or partially funded) by The University of Texas at Dallas Office of Research and Innovation and SwRI through the SPRINT grant program.



POTENTIAL FOR LIFE IN JUPITER SYSTEM

An international team that included SwRI demonstrated how complex organic molecules (COMs), key chemical precursors to life, could have been incorporated into Jupiter's Galilean moons during their formation. The team's findings resulted in complementary studies published in The Planetary Science Journal and Monthly Notices of the Royal Astronomical Society, offering new insights into the potential for life in the Jupiter, or Jovian, system.

Carbon-rich compounds containing oxygen, nitrogen and other elements are necessary for living matter to form. Laboratory experiments have shown that COMs can form when icy grains containing methanol or mixtures of carbon dioxide and ammonia are exposed to either ultraviolet radiation or moderate heating under conditions found in protoplanetary disks. These disks of gas and dust surround newly formed stars that eventually form planets.

"By combining disk evolution with particle transport models, we could precisely quantify the radiation and thermal conditions the icy grains experienced," said Dr. Olivier Mousis of SwRI's Solar System Science and Exploration Division, who is lead author of one of the two studies. "Then we directly compared our simulations with other laboratory experiments that produce COMs under realistic astrophysical conditions. The results showed that COM formation is possible in both the protosolar nebula environment and Jupiter's circumplanetary disk."

The research team developed advanced models detailing the evolution of the protosolar nebula, which formed the Sun and the planets, and Jupiter's circumplanetary disk, which formed the gas giant and its many moons. The team coupled their models with a grain-transport module that tracked the motion of icy particles through these two environments, allowing them to reconstruct the physical and chemical histories of the moon-building materials. The team focused on the formation of Jupiter's Galilean moons: Europa, Ganymede, Callisto and Io, which are Jupiter's four largest and most-studied moons.

Their findings showed a significant proportion of icy grains could have acquired COMs and efficiently transported them to the region where Jupiter's moons accreted. The research pointed toward regions in Jupiter's circumplanetary disk with sufficient heat to trigger the organic chemistry essential for COM creation. Consequently, these findings support Jupiter's moons inheriting organic material from both the larger solar nebula and from processes occurring within their local formation environment billions of years ago.

Europa, Ganymede and Callisto are believed to contain subsurface oceans beneath their icy surfaces, which are promising conditions for the evolution of life. An early incorporation of COMs into these moons means that, in addition to having water and active energy sources, the Galilean moons likely also possess the chemical building blocks that could fuel prebiotic processes, such as the formation of amino acids and nucleotides.

"Our findings suggest that Jupiter's moons did not form as chemically pristine worlds," Mousis said. "Instead, they may have accreted, or accumulated, a significant inventory of COMs at birth, providing a chemical foundation that could later interact with the liquid water in their interiors."

NASA's Europa Clipper and the European Space Agency's Juice missions are currently traveling to the Jovian system to study the composition, structure and potential habitability of Jupiter's moons.

ADVANCE WARNINGS OF SPACE WEATHER

New research by SwRI and the National Science Foundation's National Center for Atmospheric Research (NSF-NCAR) has developed a new tool providing a first step toward the ability to forecast space weather weeks in advance, instead of just hours. This advance warning could allow agencies and industries to mitigate impacts to GPS, power grids, astronaut safety and more.

"Understanding where and when large, flare-producing active regions (ARs) on the Sun would emerge is a long-standing problem in heliophysics," said SwRI's Dr. Subhamoy Chatterjee, an early-career scientist who co-authored a new Astrophysical Journal paper about this research. "These regions display tangled magnetic fields and produce explosive solar events, potentially causing hazardous space weather such as solar flares and coronal mass ejections (CMEs)."

Solar active regions do not emerge randomly. Instead, they cluster along large-scale, warped magnetic "toroidal bands." Using magnetic measurements from the Solar Dynamics Observatory Helioseismic and Magnetic Imager (SDO/HMI) from February 14, 2024, the team demonstrated that surface patterns can be inverted to reconstruct critical states beneath the surface.

Most current forecasting tools rely on small-scale magnetic signatures that become predictive only hours before eruption. The SwRI, NSF-NCAR team developed PINNBARDS, a Physics-Informed Neural Network-Based AR Distribution Simulator, to connect surface observations of solar active regions to the deep magnetic dynamics of the Sun's tachocline region. This thin transition layer is located between the uniformly rotating radiative interior and the more turbulent rotations of the outer convection zone.

By bridging surface observations and deep solar magnetic dynamics, SwRI and NCAR scientists are advancing a new generation of physics-informed, AI-enabled forecasting tools to better understand and anticipate extreme space weather. Using global magnetic information, the PINNBARDS framework offers the potential for substantially longer forecast lead times, which is critical for safeguarding satellites, communications infrastructure and future human space exploration.

"The reconstructed subsurface states from PINNBARDS provide initial conditions for forward simulations of solar magnetic evolution, opening the door to predicting where and when large, flare-producing active regions are likely to emerge weeks in advance," said Dr. Mausumi Dikpati, a senior scientist from NSF-NCAR who led the team and co-authored the paper.

The latitude and longitude of emerging active regions are critical because the location determines if resulting bursts of solar particles are destined to reach our region of the solar system.

The research was funded by NASA's Heliophysics Guest Investigator Open (HGIO) program, NSF-NCAR, and Stanford's Consequences of Fields and Flows in the Interior and Exterior of the Sun center, a NASA-funded initiative with the goal of solving some of the most difficult mysteries hidden in the deep interior of our Sun.

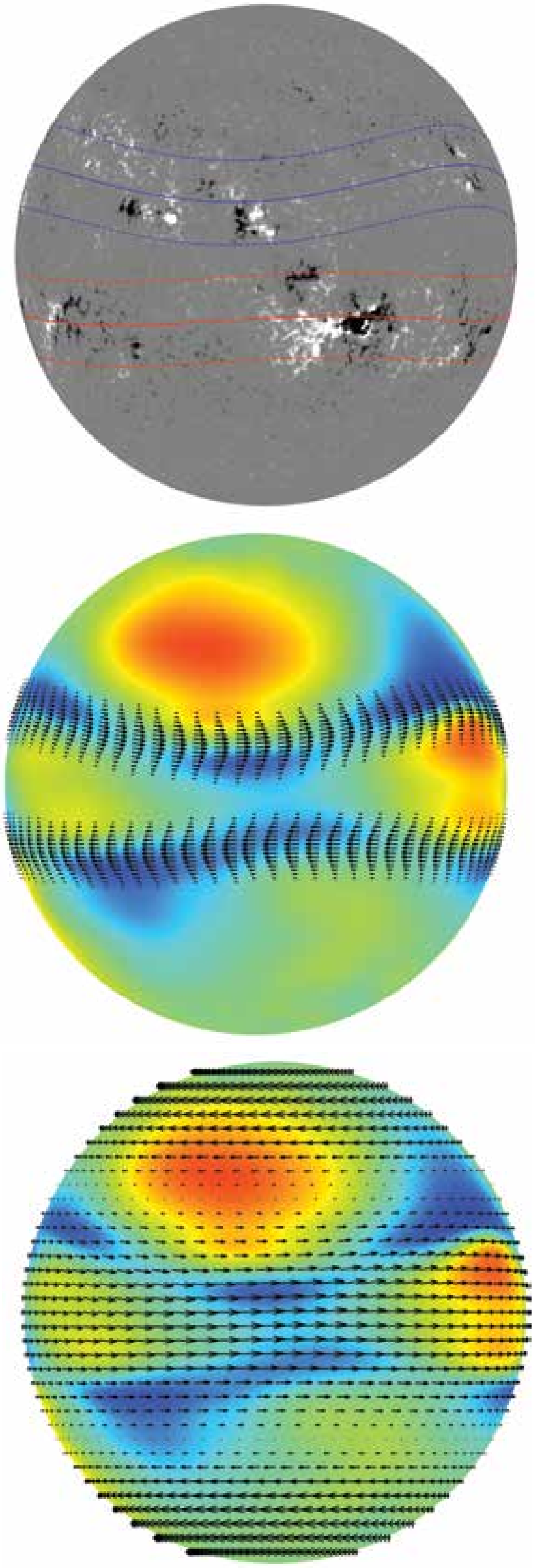


IMAGE COURTESY NASA/SDO HMI/SwRI/NCAR

Joint research by Southwest Research Institute and NSF-NCAR developed PINNBARDS — a physics-informed neural network that connects surface observations of solar active regions to the deep magnetic dynamics of the Sun. The top figure shows solar observations of two warped toroid patterns (derived from SDO/HMI magnetograms) in the southern and northern hemispheres. PINNBARDS-derived results (center) show magnetic vectors (black arrows) overlaid on bulges (red) and depressions (blue) match with observed toroidal bands. The velocity field is marked with black arrows in the bottom image. These results provide clues about the global sources of active regions that produce space weather, which can impact our technological society.

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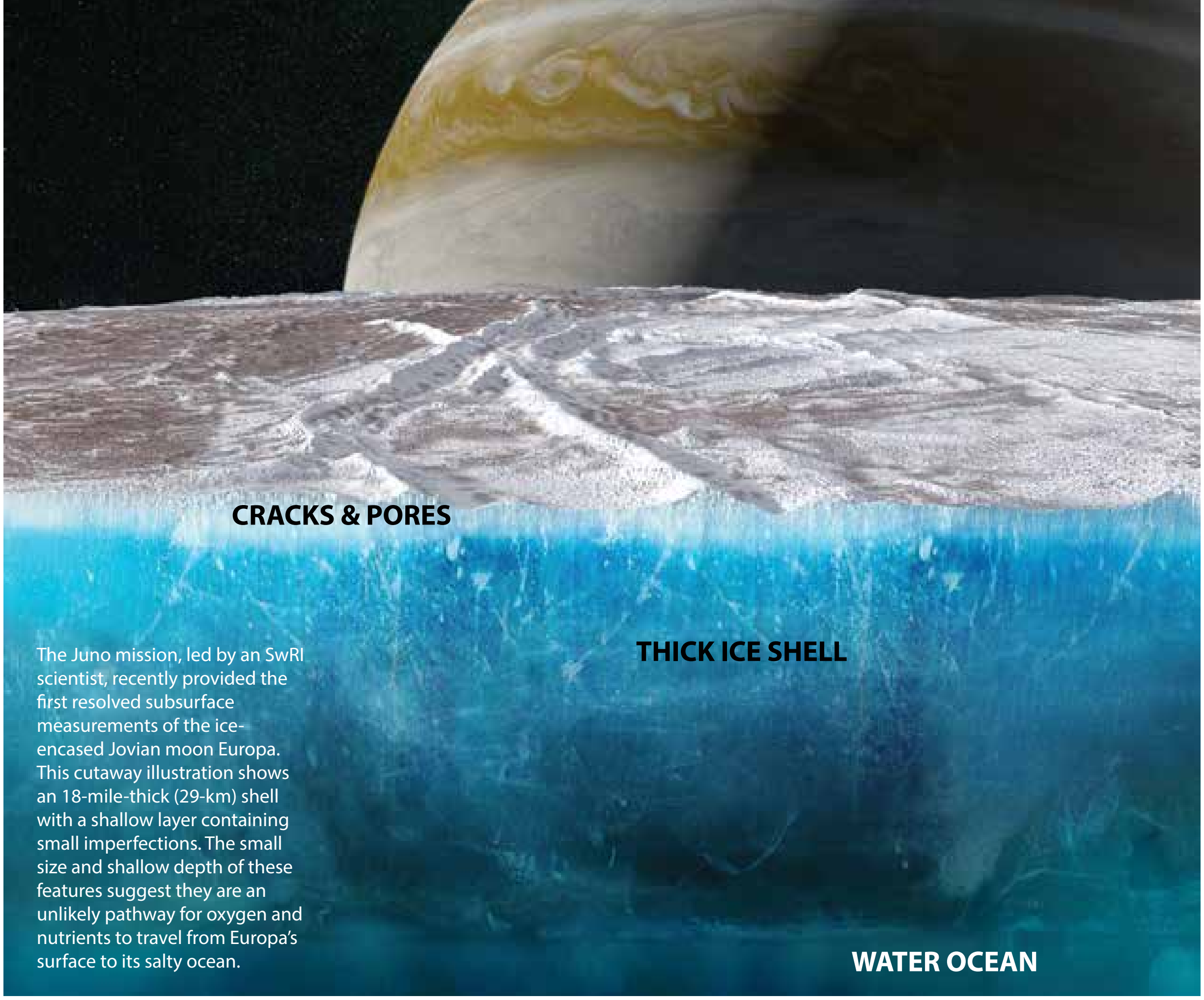

The Juno mission, led by an SwRI scientist, recently provided the first resolved subsurface measurements of the ice-encased Jovian moon Europa. This cutaway illustration shows an 18-mile-thick (29-km) shell with a shallow layer containing small imperfections. The small size and shallow depth of these features suggest they are an unlikely pathway for oxygen and nutrients to travel from Europa's surface to its salty ocean.

IMAGE COURTESY NASA/JPL-CALTECH/SwRI/KURAMURA/EICHSTÄDT

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JUNO SPACECRAFT MEASURES EUROPA'S ICE SHELL

Data from NASA's Juno mission have provided new insights into the thickness and subsurface structure of the icy shell encasing a subsurface liquid ocean within Jupiter's moon Europa. Using the spacecraft's Microwave Radiometer (MWR), mission scientists determined that the shell averages about 18 miles (29 kilometers) thick in the region observed during Juno's 2022 flyby of Europa.

The thick shell suggested by the MWR data implies a longer route that oxygen and nutrients would have to travel to connect Europa's surface with its subsurface ocean. Understanding this process may be relevant to future studies into Europa's habitability.

"The thickness of Europa's icy shell and the existence of cracks or pores within the ice shell are two crucial pieces of the puzzle for understanding Europa's potential habitability," said SwRI's Dr. Scott Bolton, the principal investigator of Juno. "They provide critical new information relevant to the further study of Europa by NASA's Europa Clipper and the European Space Agency's Juice (Jupiter Icy Moons Explorer) — both on their way to the Jovian system."

The new constraints on the ice thickness in the near-surface icy crust were published on Dec. 17, 2025, in the journal Nature Astronomy. Previous models have suggested the ice shell could be less than half a mile to tens of miles thick.

Slightly smaller than Earth's moon, Europa is one of the solar system's highest-priority science targets for investigating habitability. Evidence suggests that the ingredients for life may exist in a vast saltwater ocean believed to exist beneath its ice shell. Juno's determination of the ice shell thickness and the subsurface characteristics provides fundamental new constraints for understanding the moon's structure, internal processes and potential habitability.

The MWR instrument was invented and designed by SwRI's Bolton to investigate Jupiter's atmosphere below the cloud tops. The novel instrument has also proven invaluable for studying Jupiter's ice-covered and volcanic moons as well.

"The 18-mile estimate relates to the cold, rigid, conductive outer layer of a pure water ice shell," said Steve Levin, Juno project scientist and co-investigator from NASA's Jet Propulsion Laboratory in Southern California, which manages the mission. "If an inner, slightly warmer (convective) layer also exists, which is possible, the total ice shell thickness would be even greater."

The MWR data also provide new insights into the makeup of the ice just below Europa's surface. The instrument revealed the presence of irregularities in the near-surface ice. These cracks, pores and voids scatter the instrument's microwaves reflecting off the ice, similar to the way bubbles in ice cubes scatter visible light. These imperfections are estimated to be no bigger than a few inches in diameter and appear to extend to depths of hundreds of feet below Europa's surface.

The small size and shallow depth of these features, as modeled in this study, suggest they are unlikely to be a significant pathway for oxygen and nutrients to travel from Europa's surface to its salty ocean.

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SwRI advances its capabilities to synthesize antidotes used to combat exposure to nerve agents and pesticides. Chemists can produce kilogram quantities with 98% purity using a safer synthesis method that avoids harsh chemicals required by other methods.

ANTIDOTE MANUFACTURING CAPACITY EXPANDED

SwRI continues to expand its unique drug synthesis capabilities and expertise to advance the scalable manufacturing of safer antidotes to combat exposure to organophosphorus nerve agents (OPNAs) and pesticides.

Unlike existing manufacturing processes, SwRI's novel approach avoids cancer-causing compounds during synthesis of oxime antidotes HI-6, Obidoxime and HLö7. This makes for safer antidotes and supports the kilogram-scale manufacturing needed to sustain a domestic supply of OPNA antidotes for the United States military. End-to-end antidote production in the U.S. also reduces the risk of supply chain disruptions and other pressures that could arise during times of international conflict.

Exposure to pesticides and various nerve agents, such as OPNAs, causes an estimated 200,000 deaths worldwide each year. Nerve agents and pesticides disrupt the normal functions of the nervous system, causing a toxic buildup of a neurotransmitter used to activate muscular movement.

"Exposure to nerve agents or pesticides triggers a range of symptoms from blurry vision, nausea and vomiting to seizures, heart arrhythmias and death. Oxime compounds such as HI-6 restore the normal functionality of the nervous system after OPNA exposure," said Lead Scientist Dr. Shawn Blumberg, who developed the process at SwRI. "This is an important step to prevent further neurodegeneration."

By eliminating toxic chemical reagents during synthesis, SwRI supports safe and scalable manufacturing of well-known, highly effective medical countermeasures while continuing ongoing collaborative efforts to discover new and potentially more effective antidotes.

"Our team developed a new high-yield, high-quality manufacturing process to facilitate the domestic production of countermeasures such as HI-6, which is quickly becoming the antidote of choice due to its efficacy and versatility," said Blumberg. "We've demonstrated a new synthetic production approach that meets Current Good Manufacturing Practices."

If produced in the United States, oxime antidotes could be exported to U.S. allies around the world.

"SwRI has been supporting nerve agent antidote research for the U.S. military for about 20 years. We have created a synthesis route for oxime antidotes, allowing safer production of these drugs at commercial scales, overcoming challenges that have stymied their use since their discovery in the 20th century," said Director of Pharmaceuticals and Bioengineering Darrel Johnston.

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SwRI developed a new high-yield, high-quality manufacturing process to facilitate the domestic production of oxime antidotes, used to treat exposure to nerve agents and pesticides that can support military applications.

IMAGE COURTESY U.S. AIR FORCE 128528

SwRI is developing a Product Lifecycle Management (PLM) system to organize decades of scattered records for aging aircraft, such as the A-10 Thunderbolt, to support cost-effective proactive maintenance measures.

LIFECYCLE MANAGEMENT TO IMPROVE AIRCRAFT SAFETY

SwRI is creating a Product Lifecycle Management (PLM) system that stores and organizes decades of scattered records and data. The U.S. Air Force Academy project seeks to improve aircraft maintenance efficiency and safety through prognostic engineering, which uses data, modeling and analytics to perform repairs and maintenance before problems occur.

SwRI has decades of experience working with the U.S. military to sustain fleets of aging aircraft. Programs involve monitoring, new technology and inspection methods while addressing problems associated with information security and electronic systems.

"Many legacy aircraft were designed and maintained long before digital recordkeeping was common, so design, usage and maintenance documentation is scattered across many formats and locations," said SwRI Senior Research Engineer Martin Raming, who leads the project. "Our goal is to create a central, structured digital system for all of that information."

Integrating the PLM system with existing Air Force analysis tools will manage workflows and lay the groundwork for future digital twin development — virtual models of aircraft that incorporate mechanical, structural and avionics data for comprehensive lifecycle management.

"A PLM system will allow us to make more precise prognosis-based engineering decisions," Raming explained. "Being proactive on that level improves safety and allows the military to save money on aircraft maintenance by fixing problems before they become expensive failures."

SwRI is using existing software to build the PLM system, which will be designed to interact with other tools that determine when cracks could form or if an inspection is necessary. The software will capture workflows, creating a closed-loop system for maintenance and engineering decisions. The system will link analyses to the exact version of an aircraft model or component. When engineers revisit the analysis later, they can see precisely the information source for previous maintenance activities.

RECONSIDERING EUROPA'S VAPOR PLUMES

IMAGE COURTESY NASA 128519

Looking back at 14 years of Hubble telescope data for Jupiter's moon Europa has given SwRI scientists a better understanding of its tenuous atmosphere. The findings have cast doubt on previous evidence suggesting that the icy moon intermittently discharges faint water plumes from a presumed subsurface ocean.

"The evidence for water vapor plumes on Europa isn't as strong as we first understood it," said SwRI's Dr. Kurt Retherford, one of the authors of a 2014 paper initially making that assertion. Retherford and his colleagues have recently published a new paper reanalyzing the data.

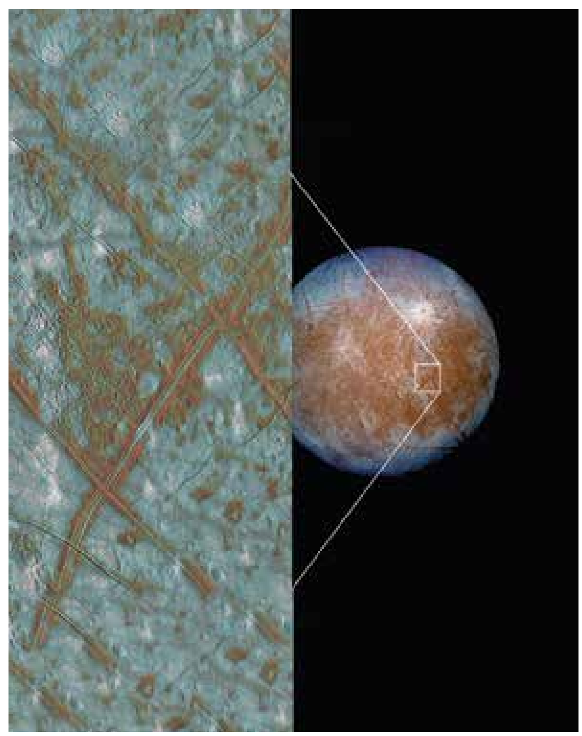
The new paper looks at the last 14 years of data from the Hubble Space Telescope's Space Telescope Imaging Spectrograph (HST/STIS) focused on Europa's Lyman-alpha emissions. Lyman-alpha is a specific wavelength of ultraviolet light emitted and scattered by hydrogen atoms. From 2012-2014, the team was pushing the limits of the Hubble telescope's capabilities.

"One of the difficulties in interpreting the data back then was determining where to place Europa within its context," Retherford said. "The way Hubble works left some uncertainty in terms of placement relative to the center of the image. If Europa's placement was off even just by a pixel or two, it could affect how the data gets interpreted."

As a result, what they thought could be evidence of a water vapor plume could also just be statistical noise.

"Our reanalysis took our original 99.9% confidence in the plumes' existence and reduced it to less than 90% confidence," said Dr. Lorenz Roth (Royal Technical Institute, Sweden), the paper's lead author. "That's simply not enough evidence to support the certainty of claims we made at the time."

Retherford said the current dataset does not rule out the possibility of the water vapor plumes described in the 2014 paper, but it no longer provides concrete evidence of them.



A new SwRI study has raised doubts about the existence of water vapor plumes on Jupiter's moon Europa (shown above), initially reported based on Hubble Space Telescope observations from 2012. A reanalysis of the data reduced the certainty of that initial finding, but scientists are still hopeful that such plumes will be observed at some point in the future.

PUNCH

7 HIGHLIGHTS from YEAR 1

PUNCH BY THE NUMBERS AS OF JULY 1, 2026

4 spacecraft create **1** virtual instrument **8,000** miles across

Downlinked **2** million images from space

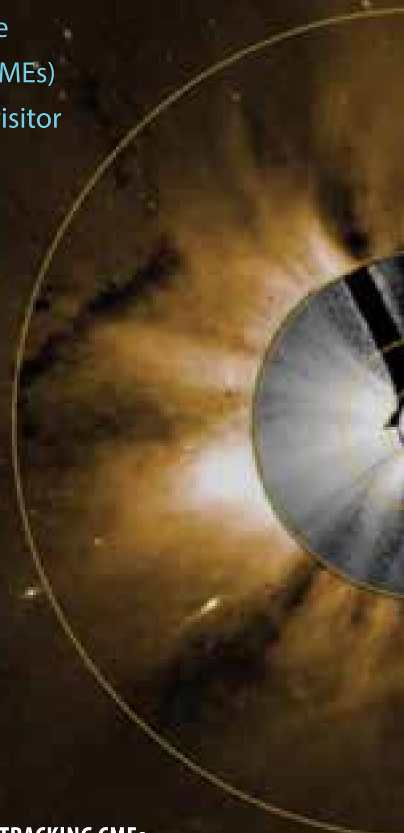
Tracked over **200** coronal mass ejections (CMEs)

Observed **7** comets including **1** interstellar visitor

1

128537

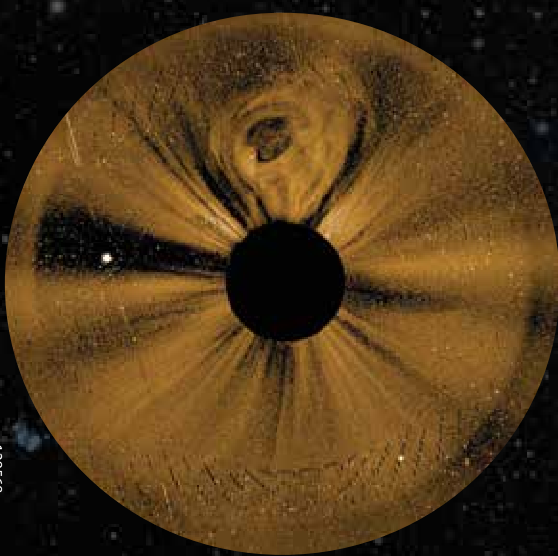
TWISTING TAIL PUNCH captured a rare event as turbulent gusts of the solar wind turned the smooth flowing tail of Comet Pan-STARRS into a twisting trail of evenly spaced, spinning knots of material. The unusual breakup and subsequent "vortex train" spanned roughly 8 million miles across the sky.



2

RADIATION CHARACTERIZATION PUNCH's gigantic field of view visually tracks solar storms moving through the solar system using new visualization tools. The Earth-directed coronal mass ejection picture here produced a modest radiation storm hours after Artemis II launched from Kennedy Space Flight Center on a historic return to lunar orbit.

128671



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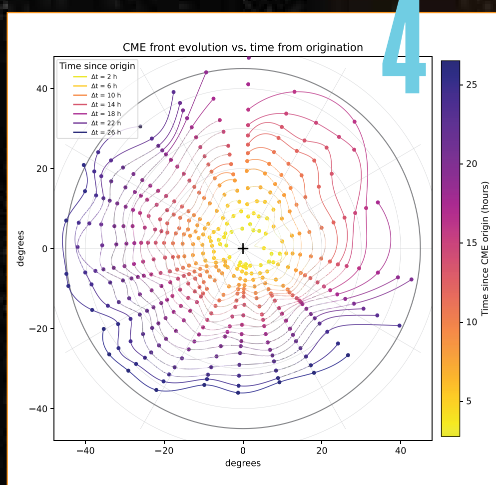
3

SOLAR EMISSIONS Before the constellation of satellites even completed commissioning, the mission's Narrow Field Imager captured early images of coronal mass ejections (top) erupting from the Sun.



4

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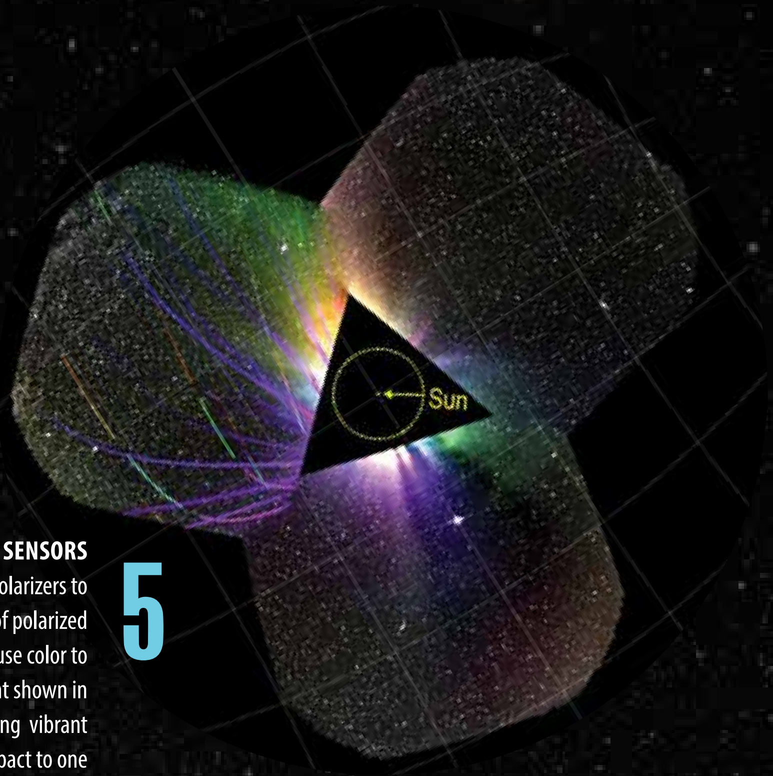
TRACKING CMEs PUNCH's wide-field imaging will improve space weather forecasts of coronal mass ejections, which become invisible to most instruments once they leave the Sun — but not to PUNCH. Scientists demonstrated how PUNCH can improve forecasts by retroactively predicting this CME's arrival at Earth (violet), using a simplified model of CME front evolution versus time of origination (yellow). The forecast nailed the arrival time, narrowing it to within 20 minutes of its actual arrival, as much as eight hours before it arrived at Earth.

NASA's Polarimeter to Unify the Corona and Heliosphere, or PUNCH, spacecraft successfully maneuvered into their final science orbits about a year ago. The four SwRI-built suitcase-sized satellites are spread out in Earth's polar orbit and act as a single virtual instrument 8,000 miles across. From this unique perspective, PUNCH images a large swath of the inner solar system, with the goal of visualizing the solar corona, the Sun's outer atmosphere, as it transitions into the solar wind that fills and defines our solar system — plus so much more. PUNCH is led by SwRI's Dr. Craig DeForest.



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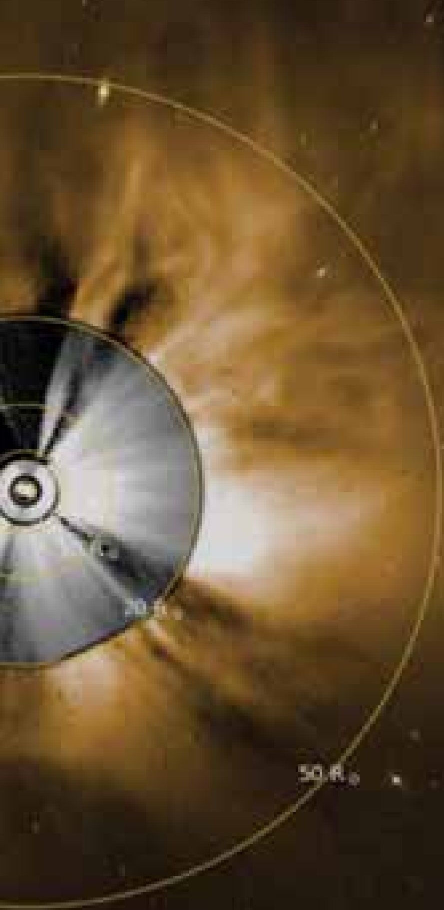
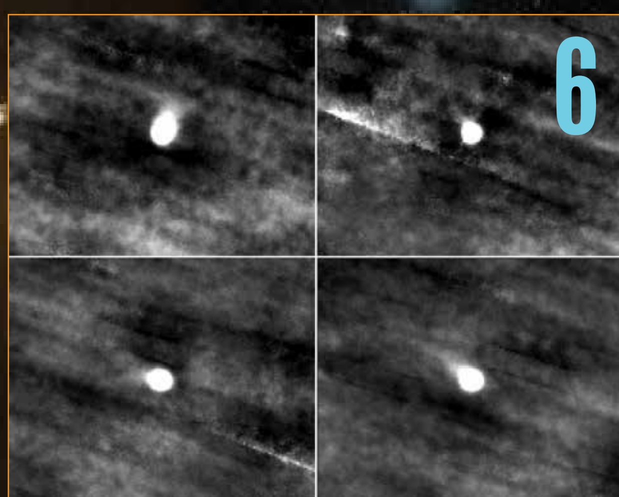
POLARIZED SENSORS
Each PUNCH instrument uses three polarizers to measure the amount and direction of polarized light from the corona. Scientists use color to represent the polarization of the light shown in this colorful preliminary data, including vibrant fireworks associated with a debris impact to one satellite. Hue represents direction of polarization, and saturation represents degree of polarization.

128542





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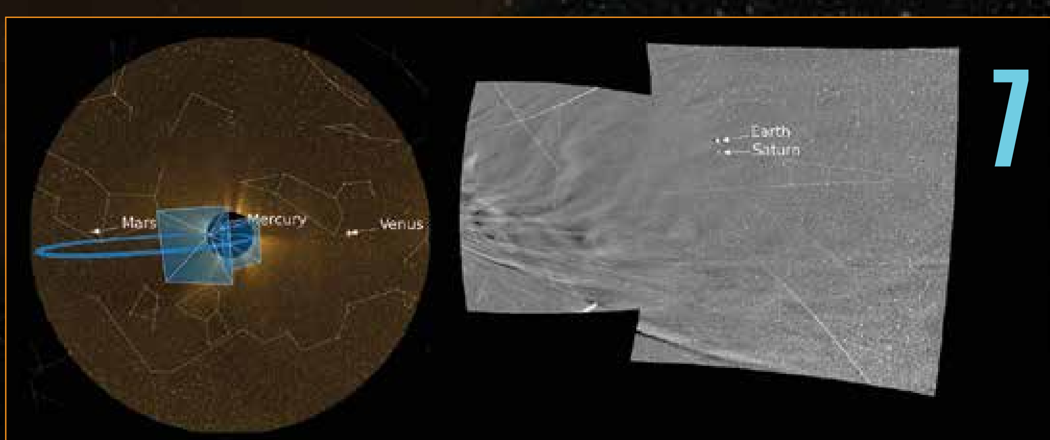
6

IMAGING INTERSTELLAR INTERLOPER The PUNCH spacecraft tracked interstellar comet 3I/ATLAS for many weeks in Fall 2025 when, from Earth, it was behind the Sun and only "visible" to telescopes designed to look at the Sun. PUNCH continuously collected roughly one image per minute of 3I/ATLAS, visualizing the evolution of the tail and its interaction with the solar wind.



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7

CELESTIAL STARING CONTEST
The orbit (left blue ellipse) of NASA's Parker Solar Probe (PSP) is always in the PUNCH field-of-view (left), allowing joint studies of coronal and solar wind physics (PSP data, right). And three times a year, the spacecraft enter into a staring contest, as PSP and PUNCH look directly at each other for a few days.

Investing in Energy

6 Facility Upgrades Enhance R&D

By Dr. Tim Allison and Shane Siebenaler

128535

Southwest Research Institute (SwRI) is entering a transformative era of energy research by aggressively investing in the physical infrastructure necessary to meet the world's most complex and evolving energy requirements. These strategic expansions across our campus are not merely structural upgrades; they represent a significant capability upgrade and fundamental commitment to our mission of advancing science and technology for the benefit of government, industry and the public. By providing independent and unbiased validation for emerging technologies, SwRI serves as a vital bridge between theoretical innovation and real-world application. Our goal is to ensure that the next generation of energy systems is safe, affordable and reliable and to provide an industry-wide resource to enable these developments.

128549

ABOUT THE AUTHORS: Dr. Tim Allison directs SwRI's Machinery Department, which performs applied research in machinery and power systems for the oil and gas, propulsion, electric power and other machinery industries. He played a key role in designing the Machinery Innovation Center for High-Energy Fluids pictured. **Shane Siebenaler** is the director of SwRI's Fluids Engineering Department, which performs applied research addressing leak detection, emissions monitoring, multiphase flow, separation, flow measurement, erosion and other flow-related topics. The department is also involved in air quality and urban heat island mitigation research.

Recent investments target the critical intersections of traditional energy infrastructure and modern power systems. This transition demands a multidisciplinary approach that leverages decades of expertise to improve mechanical, aerodynamic and thermodynamic performance. By upgrading our labs and test facilities, SwRI is improving its capabilities for large-scale technology development, reducing the costs of innovation for our clients by streamlining test setups and improving workflow repeatability. These facilities allow our engineers to measure and improve the performance of machinery and other power system components to meet specific client requirements and global standards. The following facility developments are central to this modernization strategy:

1. **The Machinery Innovation Center for High-Energy Fluids provides megawatt-scale testing for machinery operating with hydrogen, natural gas and other flammable fluids.**
2. **Upgrades to the Nitrogen Blowdown Facility streamline subsurface safety valve testing while ensuring tests meet the rigorous demands of new gas storage applications.**
3. **A major expansion to the High-Energy Annex Test (HEAT) facility tripled its airflow and pressure capabilities to better replicate conditions for utility-scale combustion systems.**
4. **Infrastructure improvements to the High-Temperature Energy Conversion and Storage (HITECS) facility provide a platform for testing thermal energy storage technologies.**
5. **By repurposing flow loops to handle various gas blends, the Metering Research Facility is helping determine how existing pipeline infrastructure can be modernized to accommodate new fuel types.**
6. **Upgrades to the High-Viscosity Flow Loop (HVFL) meet increased demands associated with processing and transporting heavy oils, including those found in multiphase flows.**

These facilities have already opened doors to significant collaborative research, including Department of Energy (DOE) projects developing machinery and thermal energy storage for energy applications and eight new hydrogen projects supported by the DOE's ENERGYWERX program (for details, see p. 29). These initiatives focus on the details of energy modernization, including the development and validation of energy system components, calibration of detection methods, evaluation of ultrasonic meters and analysis of material compatibility. By expanding our capabilities, we can now offer specialized services such as endurance or performance testing, gas analysis, component compatibility testing and leak detection assessment to a broader spectrum of industries and applications. Through these efforts, we continue to fulfill our role as a global resource, providing the technical foundation required to protect the environment and improve the human condition.

116945

SwRI's new 90,000-square-foot Machinery Innovation Center for High-Energy Fluids offers megawatt-scale testing of machinery that operates with hydrocarbons and other flammable gases.

MACHINERY INNOVATION CENTER FOR HIGH-ENERGY FLUIDS

A new hydrocarbon research facility significantly expands SwRI's research and testing capabilities, offering megawatt-scale testing opportunities for machinery and energy systems using hydrocarbons and other flammable gases. The 90,000-square-foot Machinery Innovation Center for High-Energy Fluids evaluates a range of machinery and power system components to enhance efficiency, safety and durability.

The center is designed to safely accommodate and use flammable gases, including hydrogen, hydrocarbons, organic fluids and refrigerants. Hydrocarbons such as natural gas are organic compounds composed of hydrogen and carbon atoms, which serve as a fundamental building block for many fuels, including petrochemicals. Some heat pumps also utilize flammable or otherwise hazardous refrigerants including hydrocarbons, hydrofluorocarbons or ammonia.

Flammable fluids such as hydrocarbons comprise approximately 75% of the U.S. energy supply and are pervasive for energy transport, storage and utilization in power generation and industrial processes. Testing and validation with flammable fluids is crucial to ensure system reliability and performance. These developments also allow SwRI to support emerging technologies and benefit humankind by providing an independent, unbiased and industry-wide resource.

The new facility can evaluate machinery or components such as gas turbines, centrifugal compressors, reciprocating compressors, industrial heat pumps, heaters, coolers, pumps and many other systems that use these fluids in power generation or conversion applications. The new capability accommodates flammable gases at up to 5-MW-electric motor drive (or 80-MW-thermal of natural gas) to facilitate technology development at industry-relevant conditions.

The center includes three new buildings, including an open-sided facility for drivetrains and piping systems. A 30-ton bridge crane allows the installation of heavy equipment on four dedicated machinery foundations rated for loads up to 150 tons. The electrical and control building provides up to 5 megawatts of electric power to support testing activities. Its dedicated control room features fiber-optic connections for fast data transfer across the facility. The third building houses a steam plant, and all systems connect to pre-existing infrastructure for compressed air, nitrogen, carbon dioxide and chilled water to facilitate a wide variety of testing scenarios. The facility's fuel yard safely stores and handles various flammable gases and includes overhead pipe racks to safely and efficiently transport fluids to supply processes or vent gases to the facility's flare stack.

The facility's first two projects will focus on validation testing of machinery in two novel applications. The first project focuses on validation testing of a reciprocating compressor loop with natural gas and hydrogen blending up to 20%. The test will demonstrate system and component compatibility as well as performance at blended conditions with these gases. Another project will be a first-of-a-kind demonstration of turbomachinery used in a novel propane cracking process, converting feedstocks of propane and steam to high-value olefins through turbomachinery shaft work rather than in a gas-fired heater.

DETAIL

Olefins are vital industrial materials used in plastics, detergents and synthetic fabrics.

NITROGEN BLOWDOWN FACILITY UPGRADES

SwRI's Nitrogen Blowdown Facility recreates high gas flow rates to test various equipment used in energy production, including subsurface safety valves (SSSV). These critical downhole devices are installed in oil and gas wells to prevent the release of hazardous fluids in the event of damage to surface equipment. These "fail-safe" valves automatically seal the well if control pressure is lost to prevent injury, loss of life and damage to the environment.

The Institute has provided third-party SSSV validation testing since the 1970s to support worldwide efforts to protect the environment from containment loss of wells. Several recent upgrades have significantly improved flow capabilities.

These strenuous tests for SSSVs and other pollution prevention and safety equipment support the energy and oil and gas industries as they transition to cleaner, more sustainable alternatives. One such shift is aimed at capturing and sequestering carbon dioxide (CO_2) to reduce greenhouse emissions. Subsurface locations suitable for CO_2 storage include caverns, reservoirs or depleted oil wells. SSSVs are prime candidates for safeguarding these storage applications.

SwRI has seen a rise in testing demand for equipment that can handle carbon capture and storage (CCS) applications worldwide to ensure that existing valves and safety measures will meet CO_2 storage needs. SwRI has expanded its valve testing capabilities to evaluate existing SSSVs for CCS applications and address related challenges.

For example, very cold CO_2 fluids can solidify under certain conditions. These conditions require test parameters substantially different than those required for typical oil and gas production applications, because CO_2 properties change dramatically based on temperature and increased pressure, which could lead to a catastrophic leak. Increased safety measures are required for any testing program with CO_2.

Recently, SwRI performed testing for companies involved in a joint industry project (JIP) to standardize testing procedures for validating valves for use in CCS environments. The team also participates in international standards development, including new standards for equipment related to CCS.

These efforts, combined with the rising demand for CCS-related testing, prompted SwRI to upgrade its testing capabilities to enhance safety, improve efficiency and reduce costs for clients. SwRI redesigned its facilities, including those complementing the Nitrogen Blowdown Facility, to streamline test setups, reducing labor costs by improving the repeatability of workflows. Modifications include an ergonomically improved enclosure as well as a new plug-and-play design tailored specifically to easily add thermal ducting for the below-ground test enclosure used to test valves at extreme temperatures.

The fully assembled test setup can be dropped into the test pit as a prepackaged unit, eliminating the need for intricate maneuvers over the facility. The result is a safer, higher efficiency, and more consistent testing process. These changes enhance existing benefits,

128497

SwRI has made extensive upgrades to its facilities to offer more efficient and cost-effective subsurface safety valve testing to meet the demands of intense carbon capture and storage environments.

including a high-quality nitrogen source, a highly reliable and time-tested leakage measurement system, and an experienced staff with decades of expertise.

The facility cools the SSSVs using a duct system that flows liquid-nitrogen-cooled air around the test article. This method allows the operator to reliably reach the extreme cold temperatures required to simulate CCS conditions while avoiding challenges such as icing.

SwRI is currently pursuing additional testing opportunities, such as cooled gas slam tests that simulate the worst-case dynamic scenarios in CCS environments.

128501

The SSSV facility cools the test chamber using liquid nitrogen.

HEAT FACILITY EXPANSION

SwRI has made significant improvements to its High Energy Annex Test (HEAT) facility to support highly efficient gas turbine combustor testing. An internally funded research project designed new technology that expands HEAT's capabilities, to better serve evolving industry needs, particularly for alternative fuel applications.

SwRI founded its HEAT facility in 2016 in response to a client request for gas turbine combustion system test support. Gas turbine combustion modeling is an important tool, but real-world testing is a crucial step before deploying any technology to the field. SwRI created a facility with controlled air, fuel and temperature supplies to test how combustors actually perform under realistic conditions. The HEAT facility supports physical combustor testing to validate designs, performance and safety under real conditions.

The facility is designed to run continuous, high-quality tests at high capacity, a rare capability that simulates how turbines operate in the real world. In recent years, SwRI identified improvements to lower the cost of combustion testing, which included designing and testing a new combustion rig concept utilizing additive manufacturing for multiple features, including the combustor liner. This approach can lower costs compared to traditional methods.

SwRI also improved the HEAT facility to address decarbonization challenges and the demand for cleaner, lower-carbon fuels. This entailed expanding HEAT's fuel supply system to support hydrogen, ammonia and synthetic fuel testing. The upgrade also reduced test consumable costs by integrating a continuous low-cost gas supply, compressing and storing pipeline-transported natural gas from our utility rather than trailer-based methane or liquefied natural gas supplies. The system will be upgraded to accept liquid fuels such as diesel, biodiesel and synthetic aviation fuels.

In 2025, HEAT received a powerful new air compressor that expanded its ability to run higher-pressure tests that more realistically simulate real turbine conditions. This upgrade tripled HEAT's airflow and pressure capabilities — up to 14 pound-mass per second and 300 pounds per square inch absolute — to support a wider range of combustion system testing at relevant flow rates and pressures. An ejector uses the facility's air supply and pre-heater to create test conditions for aerospace propulsion applications up to Mach 4.0 and altitude conditions up to 88,000 ft.

128521

SwRI's High Energy Annex Test (HEAT) combustion facility includes a new, powerful air compressor to explore how alternative fuels affect the performance of gas turbine combustion systems.

128527

SwRI upgraded its Metering Research Facility to help several industries evaluate how blending hydrogen with natural gas affects infrastructure and technology.

DETAIL

SwRI originally developed the Metering Research Facility for the Gas Research Institute in 1991 as an industry resource to research, develop and test flow meters and to support gas handling machinery and piping system programs. The natural gas flow calibration laboratory transitioned to become an SwRI-owned facility supporting client research in 2004.

METERING RESEARCH FACILITY EXPANSION

Southwest Research Institute's world-class Metering Research Facility (MRF) is a high-accuracy facility for flow meter development, calibration, research and testing. MRF's high-pressure loop provides highly accurate and repeatable tests under a wide range of actual field conditions.

SwRI has expanded MRF'S capabilities to ensure existing natural gas infrastructure is compatible with hydrogen fuels. This initiative is supported by internal funding and combines SwRI's expertise in energy, power and automotive engineering to help several industries evaluate how blending hydrogen with natural gas affects infrastructure and technology.

Blending hydrogen into natural gas pipelines could prove to be a promising, cost-effective pathway to reduce greenhouse gas emissions using existing natural gas infrastructure. The industry is studying using hydrogen-natural gas blends to generate electricity and in home appliances such as heaters and ovens without impacting equipment or performance.

To support this transition, the team repurposed one of two flow loops within the MRF previously used to study flow measurement and compression for low-pressure natural gas applications. Modifications allow the facility to test hydrogen-natural gas blends and explore the effects on pipeline systems, components and flow measurement technologies.

The upgraded facility now features an injection system to introduce hydrogen into the natural gas stream as well as other compatibility upgrades. These include a new safety system to detect both hydrogen and natural gas leaks. The upgraded system can simulate transmission, distribution and end-use scenarios for natural gas-hydrogen blends.

Initial studies are focusing on blends of natural gas with 5-25% hydrogen, pursuing both internal and client funding to understand how introducing hydrogen affects existing energy infrastructure. The enhanced facility now supports flow measurement testing, endurance evaluations, gas analysis, component compatibility analysis, leak detection and general component testing for clients. SwRI continues to dedicate a multidisciplinary team to hydrogen energy research initiatives, supporting efforts to decarbonize a broad spectrum of industries.

HIGH-TEMPERATURE THERMAL ENERGY CONVERSION & STORAGE

In 2022, SwRI demonstrated a complete pumped thermal energy storage system at the 50 kW scale in its High-Temperature Thermal Energy Conversion and Storage (HITECS) facility. With that expertise, the team pursued additional projects to develop and test thermal energy storage technology, requiring upgrades to handle the size, weight and electrical supply needs at ranges to support industry scale-up. These technologies are long-duration energy storage solutions providing cost-effective alternatives to electrochemical batteries to store energy from renewable resources. Because thermal energy storage technologies discharge heat directly without conversion back into electricity, they are particularly useful for zero-carbon heating applications, functioning as a bridge between variable renewable power sources and 24/7 heat demands.

Prior to the upgrade, the facility included control and instrumentation rooms and an outdoor 9,500-square-foot concrete slab with a 100-kW power supply. The facility upgrade expands the slab by an additional 12,000 square feet capable of supporting heavy equipment. An expansion of the western portion of SwRI's electrical grid upgrades site power to approximately 6.5 MW-electric.

The upgraded HITECS tests larger thermal energy storage systems, evaluating modules to support hundreds or thousands of megawatts end-use applications. The HITECS facility neighbors SwRI's STEP Demo 10-MW-electric pilot plant and chemical engineering pilot plants, to facilitate future potential projects integrating thermal storage with power generation or chemical process applications.

The HITECS facility is already engaged in two thermal energy storage projects. The first project is testing client technology incorporating refractory bricks chemically modified to increase their electrical conductivity. These "e-bricks" are effectively scalable high-temperature heating elements, and when combined within a matrix of conventional nonconductive bricks, they can be charged directly with electricity. SwRI is evaluating this first-of-a-kind technology using hot air discharge techniques. The second project is developing and testing molten salt in an actively managed thermocline energy storage tank. This cost-saving technique reduces the number of tanks needed by storing both hot and cold heat-transfer fluids separated by a natural stratification layer, actively managed to improve performance.

DETAIL

The Supercritical Transformational Electric Power (STEP) pilot plant is one of the largest demonstration facilities in the world for sCO_2 technology, achieving full operational speeds and temperatures. The pilot plant differs greatly from conventional power plants because it uses high-temperature sCO_2 instead of water as a thermal medium in its power cycles, increasing efficiency by as much as 10% due to its favorable thermodynamic properties.

DETAIL

Refractory bricks are specialized ceramic blocks designed to withstand temperatures exceeding 2700°F (1480°C), primarily used to line furnaces, kilns, wood stoves and fireplaces.

128551

SwRI is testing a client's 20 MWh, 1,800 degrees Celsius thermal storage system at its upgraded HITECS site.

HIGH-VISCOSITY FLOW LOOP

SwRI upgraded its High-Viscosity Flow Loop (HVFL) to meet increased demands associated with transporting and processing heavy oils. The expanded and upgraded facility allows SwRI to offer more comprehensive, efficient and cost-effective heavy oil testing.

Increasing production of heavy oil around the world led SwRI to develop the HVFL in 2015 to gain a better understanding of how flow equipment performs when handling these extremely viscous fluids. Viscosity describes a fluid's resistance to motion. Heavy crude oil is typically a dense, high-viscosity fluid exhibiting strong bonds between its molecules. The slow-moving substance is incredibly thick and sticky, like molasses or tar. This "thickness" is highly dependent upon the temperature of the fluid.

As industry taps into reservoirs with higher gas volume fractions, conventional pumping systems can struggle to process the volatile mixture of gas and liquid, demanding advanced gas separation technologies. SwRI addresses these challenges, evaluating pump performance with highly viscous fluids while also handling gas mixed into the fluid stream, simulating fluids with multiple phases (e.g., liquid and gas).

In industrial drilling systems, produced oil is rarely single-phase and often has natural gas mixed into the production fluid. The introduction of gas into equipment designed for liquid operations can impact equipment performance. Multiphase testing heavy oils can be costly, as most facilities are not optimized to handle highly viscous fluids.

SwRI modified the HVFL to inject air into liquids to evaluate how pumps designed for single-phase liquid flow will handle multiphase flows. The research is transitioning to handle heavy oils as well, in addition to testing multiphase flows with different viscosities.

The HVFL complements SwRI's Multiphase Flow Facility, which offers multiphase flow testing at lower viscosities, but over a wide range of flow conditions.

In addition to the new multiphase capability, SwRI redesigned and optimized the HVFL, creating permanent infrastructure to provide cost-effective and efficient testing. The upgrade also improved environmental safety by extending the facility's oil containment barrier to fully enclose the test setup.

Questions about this story? Contact Dr. Tim Allison at (210) 522-3561 or tim.allison@swri.org or Shane Siebenaler at (210) 522-5758 or shane.siebenaler@swri.org.

128543

SwRI redesigned and optimized its HVFL, creating more permanent infrastructure to enable efficient cost-effective testing with heavy oils, including high-viscosity multiphase flows.

INSIGHT INTO SOLAR FLARE MECHANISMS

A new study led by SwRI links quasi-periodic pulsations (QPPs) in solar flares to dynamic oscillations in magnetic reconnection, phenomena that can drive space weather and affect technology on Earth. This research could help refine traditional solar flare models and provide new insights into the mechanisms driving them.

Magnetic reconnection occurs when magnetic field lines in plasma break and reconnect, releasing immense energy into the surrounding atmosphere that can result in space weather. Solar flares are intense, transient bursts of energy on the Sun's surface and are the most common and spectacular examples of solar weather. QPPs, oscillating signals emitted across the electromagnetic spectrum, are often associated with solar flares. However, their origins and the functions driving them have eluded explanation.

"Solar flares are the largest eruptive phenomena in our solar system, but the mechanisms behind quasi-periodic pulsations have remained a mystery," said Dr. William Ashfield IV, postdoctoral researcher in SwRI's Solar System Science and Exploration Division. He is lead author of a Nature Astronomy paper describing new findings about these phenomena. "While QPPs appear in around 50% of large solar flares, they are still poorly understood. We wanted to get a better sense of why they occur and figure out how they fit into the energy release process."

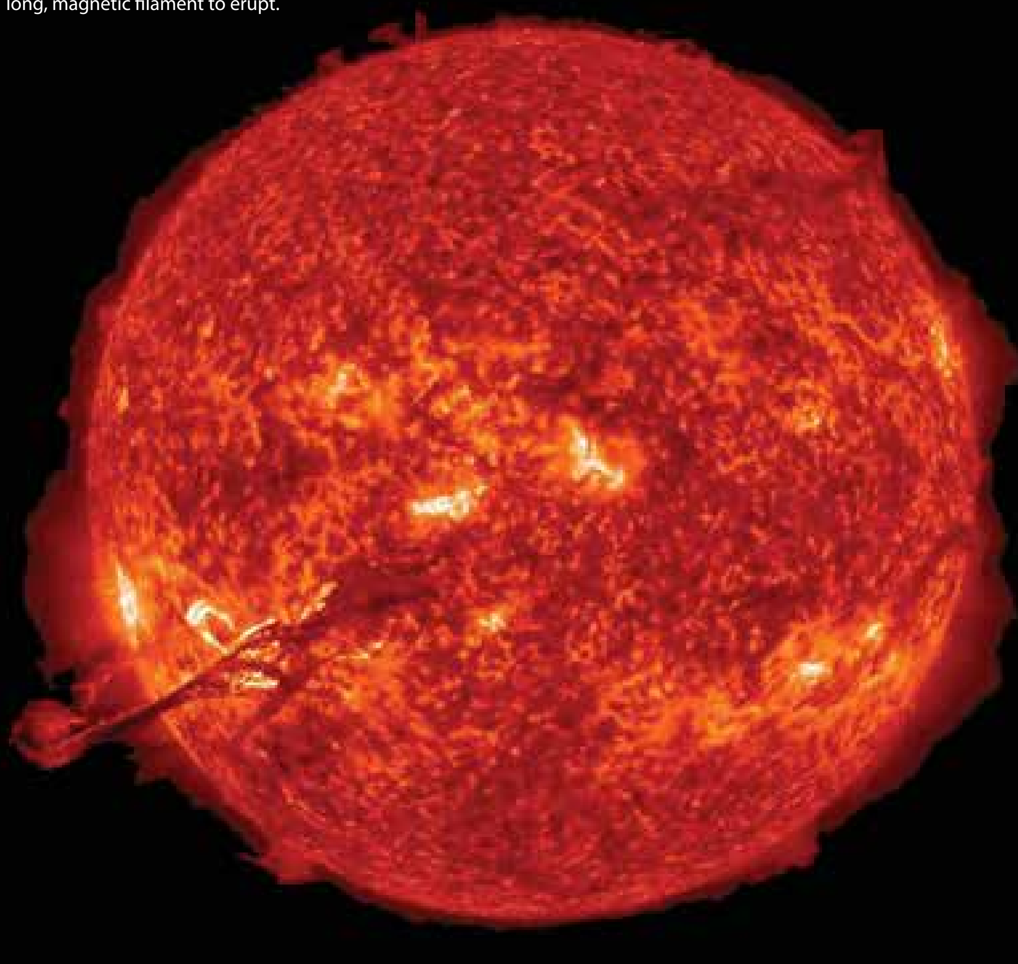
To better understand the nature of QPPs, the researchers used high-resolution observations from the Swedish Solar Telescope in the Canary Islands and precise spectroscopic data from NASA's IRIS telescope in Sun-synchronous orbit. The researchers observed a moderate-strength solar flare and conducted a pixel-by-pixel spectroscopic analysis to capture QPP evidence successfully.

"The complementary observations from ground-based and space-based telescopes allowed us to rule out competing theories and narrow down potential driving mechanisms behind QPPs," Ashfield said. "Our findings suggest that repeated magnetic reconnection may be what leads directly to the QPPs observed in this solar flare."

According to Ashfield, the study highlights the need to incorporate oscillatory behavior into magnetic reconnection theories, providing constraints to guide future research.

"Understanding QPPs isn't just about understanding the solar flares themselves," Ashfield said. "Our research lays a foundation for future studies to use larger datasets and advanced simulations to deepen our understanding of space weather events and other astrophysical phenomena associated with magnetic reconnection."

SwRI-led research suggests that repeated magnetic reconnection may be what leads directly to quasi-periodic pulsations observed in solar flares, such as this medium-sized flare, which sparked a long, magnetic filament to erupt.



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IMAGES COURTESY SWEDISH SOLAR TELESCOPE/NASA SDO

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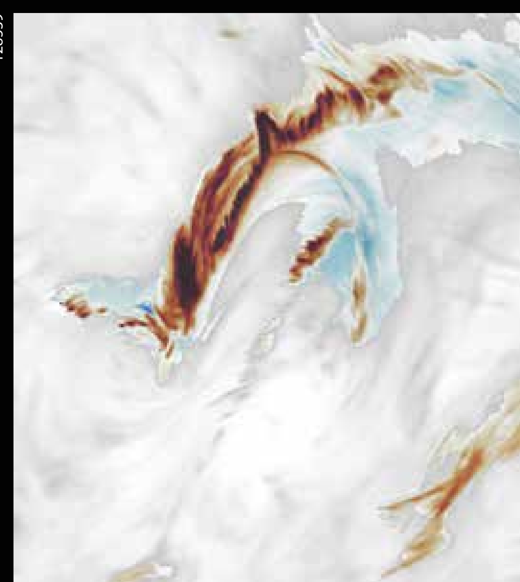

New SwRI-led research connects circular flare ribbons with energy released by repeated bursts of magnetic reconnection and quasi-periodic pulsations, finding plasma flowing downward (red) and upward (blue), respectively. Downward flows pulsed in time across the entire ribbon suggest that magnetic field lines breaking and reforming release tremendous amounts of energy that drive the entire flare.

SwRI EXPANDS ENVIRONMENTAL MANAGEMENT CERTIFICATION

SwRI has achieved ISO 14001:2015 certification for its fire technology, pharmaceutical development, analytical and environmental chemistry, and chemical engineering research areas. The internationally recognized environmental management framework supports proactive systems and operations to reduce emissions and protect the environment.

"While we already had many of the systems in place required to meet this accreditation, we took the important next step of formalizing it," said Karen Martinez, director of SwRI's Fire Technology Department. "The ISO 14001 accreditation should give our clients peace of mind knowing we're doing everything possible to protect our community and environment."

To achieve this expanded third-party certification, SwRI's quality assurance team worked for two years to train staff to maintain proper documentation and adhere to the standard before undergoing external audits. SwRI's automotive engineering research activities had previously received ISO 14001:2015 certification.

"At SwRI, stewardship is one of our core values. We already maintain strict systems to prevent air and water pollution during our operations," said Colby Tate, a manager on SwRI's quality assurance team. "The rigorous process for obtaining certification gives our clients one more reason to work with us."

Conformance to ISO 14001:2015 requires compliance with both external and internal rules, regulations and permits regarding environmental aspects, with an emphasis on continual improvement along with regular audits by ISO-certified bodies.

"SwRI's fire testing activities use a customized pollution abatement system to capture smoke and other toxic particulates, keeping them out of the air we breathe. This system is crucial to our fire testing and a big part of how we achieved this ISO accreditation," said Martinez.

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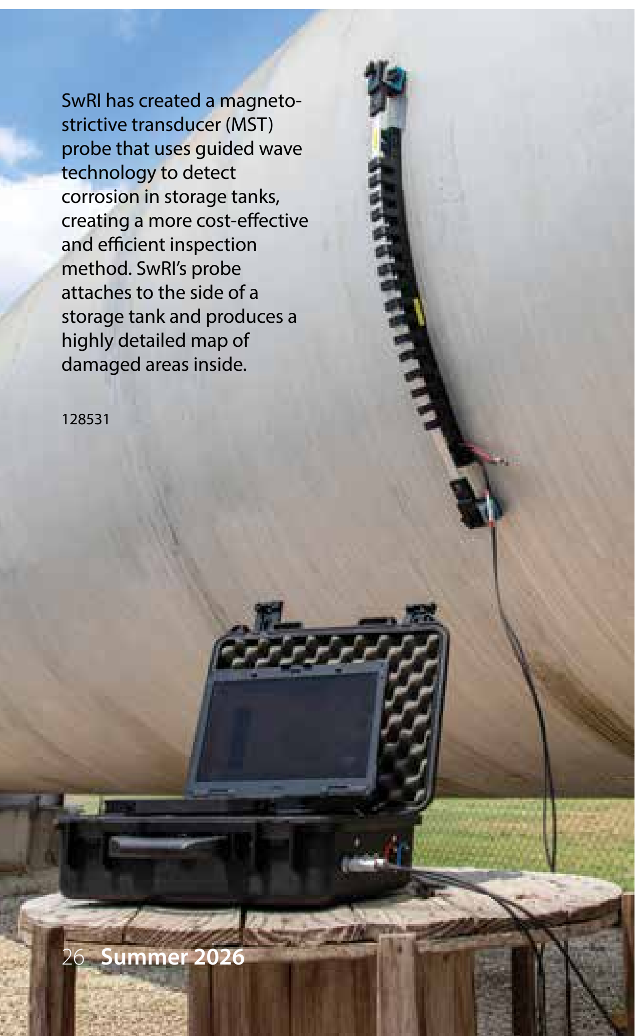
SwRI has expanded its ISO 14001 certification, an internationally recognized environmental management framework, to proactively reduce emissions and protect the environment during operations. SwRI's fire testing laboratories are equipped with a custom pollution abatement system (seen here) to ensure pollutants are not released into the environment during testing.



SwRI has created a magneto-strictive transducer (MST) probe that uses guided wave technology to detect corrosion in storage tanks, creating a more cost-effective and efficient inspection method. SwRI's probe attaches to the side of a storage tank and produces a highly detailed map of damaged areas inside.

128531

SAFER STORAGE TANK INSPECTIONS

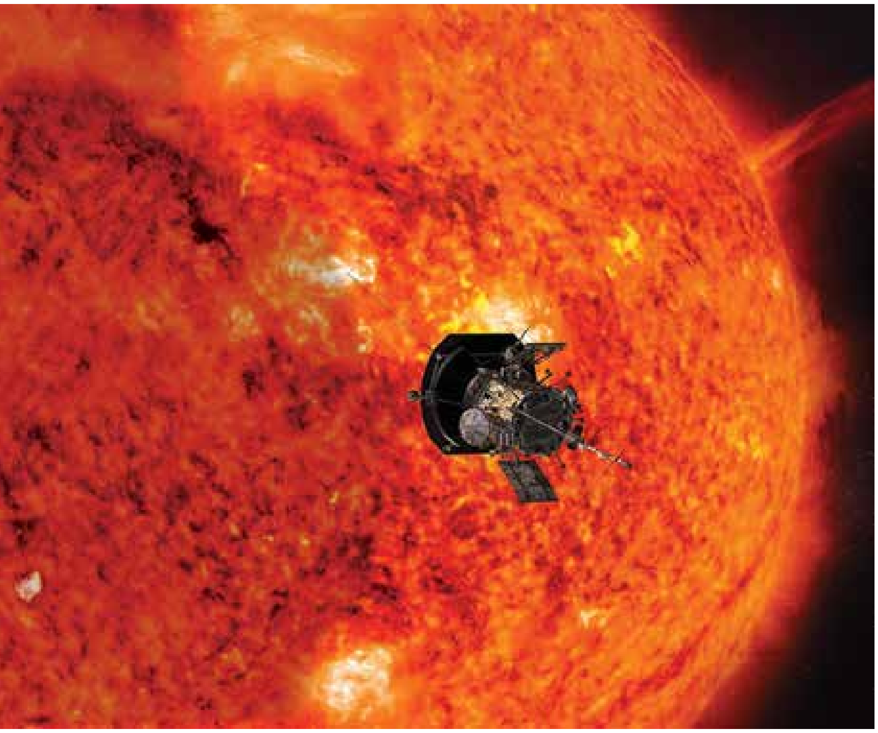
SwRI has created a magnetostrictive transducer (MST) probe that uses ultrasonic guided wave technology to detect corrosion in storage tanks, a process that normally requires emptying the tank and checking for corrosion manually. SwRI's probe attaches to the outside of a storage tank, resulting in a more cost-effective and efficient method of corrosion detection.

The SwRI MST 8x8 is a flexible strip of eight ultrasonic sensors that generate acoustic waves along a structure. The technique identifies anomalies when the waves are reflected back to the sensor by corrosion and other flaws. Specifically, the probe uses shear horizontal guided waves, which are ideal for detecting defects because of their sensitivity and precision. SwRI is a leader in advanced inspection technologies, with considerable expertise in MSTs.

"Many industries require storage tanks to be inspected regularly," said SwRI's Dr. Sergey Vinogradov, author of a recent paper detailing the efficacy of the SwRI MST 8x8. "This can be a very expensive process, as it requires the tank to be emptied, cleaned and manually inspected. By allowing inspection without emptying the tank, our probe reduces expensive downtime and improves inspection safety, by avoiding work in hazardous, confined spaces."

SwRI performed rigorous field testing of the probe on a series of storage tanks, though the technology can also be applied to ship hulls, wind turbines, rocket bodies, pipelines and other structures. The probe's array of eight sensors also allows it to collect data from multiple angles, increasing accuracy.

"Data from the probe are processed with an advanced imaging algorithm, the total focusing method, that generates these maps," Vinogradov said. "As a result, instead of just indicating the presence of an anomaly, it can create a high-resolution map of the structure, showing areas with potential corrosion. This helps users assess the extent of damage to decide when to schedule expensive, time-consuming tank repairs."



SUN'S COMPLEX MAGNETIC ENGINE

A SwRI-led study found that protons and heavy ions react differently to solar magnetic reconnection events, revealing a more complex magnetic engine powering the solar wind.

Magnetic reconnection converts magnetic energy into explosive kinetic energy, powering solar events and causing space weather that impacts Earth. Magnetic reconnection energizes protons and heavy ions, sending them shooting out of the Sun at high speeds.

Current models assume all these particles react the same way, but new data obtained by NASA's Parker Solar Probe show distinct differences in particle acceleration. While heavy ions shoot out straight like a laser beam, protons create waves that scatter subsequent particles in a dispersed pattern, more like a flashlight.

"These new data rewrite our understanding of reconnection," said SwRI's Dr. Mihir Desai, lead author of a new paper about this research. "Protons and heavy ions show distinct spectra that contradict current models. Protons generate waves that scatter them more efficiently, while the heavy ions stay beam-like and retain their accelerated spectral shapes."

Magnetic reconnection is a ubiquitous phenomenon in the universe, where magnetic field lines converge, break apart and reconnect. At the Sun, the explosive physical process energizes particles and generates high-speed flows, driving space weather events such as solar flares and coronal mass ejections. Understanding how magnetic reconnection works is critical for predicting hazardous events and protecting life and technological assets on Earth and in space.

"What we are learning is that the Sun's 'magnetic engine' is far more complex than we imagined," Desai said. "This is incredibly exciting because it demonstrates that our own star acts as a local, accessible laboratory for the same high-energy physics — like particle acceleration and magnetic snapping — that powers the most violent and mysterious phenomena in the universe, from black holes to supernovae."

NEW INSPECTION METHODS FOR AIR FORCE AIRCRAFT

SwRI has received a contract from the U.S Air Force Academy to characterize inspection methods for bolt holes in aging aircraft to inspect through bushings without removing them. Assessing bolt hole condition through inspection supports wider efforts that inform repair decisions and ensure aircraft safety.

For decades, SwRI has supported the U.S. Air Force's Aircraft Structural Integrity Program (ASIP) and the U.S. Air Force Academy Center for Aircraft Structural Life Extension (CAStLE), which ensures that aging military aircraft can continue to fly safely. These programs use damage tolerance analysis, aircraft usage data, and the results of nondestructive inspections to establish regular inspection intervals to extend the life of aging structures.

"It's important to inspect locations where stress can lead to damage," said SwRI Senior Research Engineer Nathan Richter, who oversees the project. "We use nondestructive evaluation (NDE) methods in areas where cracks may form. NDE helps detect damage without altering or removing a part and its sensitivity varies with the flaw size."

Bolt holes require careful monitoring, because they exist in high-stress areas of the aircraft. When cracks or wear develop around a bolt hole, the damaged material is often replaced with a cylindrical metal sleeve called a bushing.

"Inspecting bushing-repaired holes is challenging because the bushing must be removed, risking further damage to the hole during removal and reinstallation," Richter said.

To address this, SwRI is using low-frequency eddy current testing, an NDE technique that applies electromagnetic fields to detect and characterize subsurface flaws and cracks without removing the bushing. These results will then be used to develop probability of detection, or POD, curves to characterize the flaw detection capability of the method.

SwRI has received a contract from the U.S. Air Force Academy to characterize inspection methods for bushing-repaired bolt holes in aging aircraft. Assessing bolt hole condition through inspection supports wider efforts that inform repair decisions and ensure aircraft safety.

128517

SwRI RELEASES 2025 IR&D REPORT

SwRI has released its 2025 Internal Research & Development (IR&D) Annual Report online, showcasing internally funded projects conducted by the Institute in 2025.

SwRI's IR&D program provides staff with funding to encourage scientific discovery, address clients' future needs and fulfill the Institute's mission of benefiting humanity. It provides SwRI scientists and engineers with the freedom to explore innovative, unproven concepts to tackle emerging industry challenges, transforming novel and innovative ideas into new technical discoveries, developments and applications.

In fiscal year 2025, SwRI invested more than $13 million to fund IR&D projects that pioneer new technologies, expand institutional knowledge and capabilities, and encourage the professional growth of its staff.

"Southwest Research Institute's IR&D Program represents a significant investment of time and financial resources to explore new ideas for the mutual benefit of the Institute and its clients," said Walter D. Downing, SwRI executive vice president emeritus and administrator of the 2025 Advisory Committee for Research, which oversees the program. "SwRI's IR&D program demonstrates the viability of innovative technologies in potential applications using real results. The IR&D program is frequently cited as a key enabling factor leading to new projects, new clients and new program areas within the Institute."

SwRI staff initiated 141 new IR&D projects in 2025. An additional 108 previously funded projects continued throughout the year, totaling 249 active internally funded projects. The projects represent a wide swath of research disciplines, industries and market segments, including automotive and transportation, Earth and space, defense and security, and biomedical and health research.

Using funding from the SwRI IR&D Program, engineers developed a learning-based framework that integrates residual stress insights from physics-based simulations with real-world assembly variations to optimize welding of large structures. The resulting robotic system increases the service life and performance of large structures such as ships while reducing post-fabrication rework.

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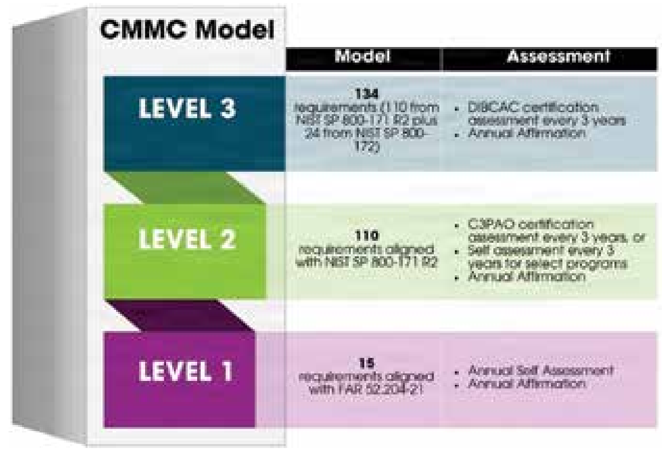

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CMMC CYBERSECURITY CERTIFICATION EARNED

Two divisions at SwRI have officially achieved CMMC Level 2 certification through an independent, third-party assessment, demonstrating a commitment to cybersecurity best practices for government and industry.

The U.S. government created the Cybersecurity Maturity Model Certification (CMMC) Program to enhance security of sensitive information. It provides a framework designed to validate requirements recommended by the National Institute of Standards and Technology.

"Our leadership has made a significant investment into CMMC," said Stephan Polinsky, SwRI's chief information security officer. "SwRI is working to integrate these practices into business lifecycles to ensure consistent adherence to secure procedures across the organization for years to come."

The certification applies to SwRI's Intelligent Systems and Mechanical Engineering divisions. Level 2 certification can only be obtained through an independent self-assessment authorized by a third-party CMMC assessment organization.

"This independent assessment demonstrates a commitment to the rigor of the process," said Dr. Steve Dellenback, vice president of the Intelligent Systems Division. "We are proud to be an early adopter and to have achieved the Level 2 certification."

To obtain Level 2 certification, SwRI had to meet 110 requirements related to topics such as access controls, awareness, training, accountability, incident response, personnel security, physical protection and more. The certification will be up for renewal in three years. SwRI will affirm its compliance with security requirements annually.

"Adhering to the CMMC program increases our cybersecurity capabilities, allowing us to better protect our clients' data," said Dr. Barron Bichon, vice president of the Mechanical Engineering Division. "And over time, the entire Institute and our clients will benefit through a culture that promotes maturing processes."

SwRI's Intelligent Systems Division specializes in applied research using computer science and engineering disciplines to solve automation challenges in the transportation, manufacturing and medical environments. The Mechanical Engineering Division develops technical solutions for multiple industries, from energy to ballistics, materials and structures, to improve efficiency and productivity.

HYDROGEN ENERGY RESEARCH

SwRI has received funding from the ENERGYWERX program to support hydrogen-related research. The eight projects are evaluating technology to improve energy infrastructure and support the use of this clean-burning fuel.

SwRI scientists and engineers across multiple disciplines are working together to prepare for a future hydrogen economy. The ENERGYWERX program funds cooperative research activities between the Department of Energy and nonprofits, private companies, utilities, localities and other organizations to accelerate the development of clean energy technologies and solutions.

The eight projects are:

- Pressure cycle testing a hydrogen check valve to support high-pressure gaseous hydrogen refueling.
- Evaluating the reliability of valves repeatedly exposed to high-pressure hydrogen gas and extreme temperatures, conditions that can embrittle metals and damage sealing elements, making them prone to leaks.
- Establishing facilities and methodologies to support comprehensive hydrogen component testing, highlighting safety, reliability, performance and compliance with global standards.
- Testing ultrasonic meters adapted to measure the flow of hydrogen-natural gas blends as well as evaluating the performance of the new meters with existing pipeline transmission technology.
- Assessing a new gas analysis sensor designed to detect hydrogen and methane content in hydrogen-natural gas blends.
- Testing and validating a hydrogen gas analysis sensor for sensitivity, response time and accuracy.
- Calibrating detection methods against known hydrogen leak scenarios to reinforce safety protocols with real-time detection.
- Evaluating the compatibility and safety of using O-ring materials in hydrogen gas environments.

SwRI is conducting many of the projects in its Metering Research Facility. The ENERGYWERX projects are expected to be completed by the end of 2026.

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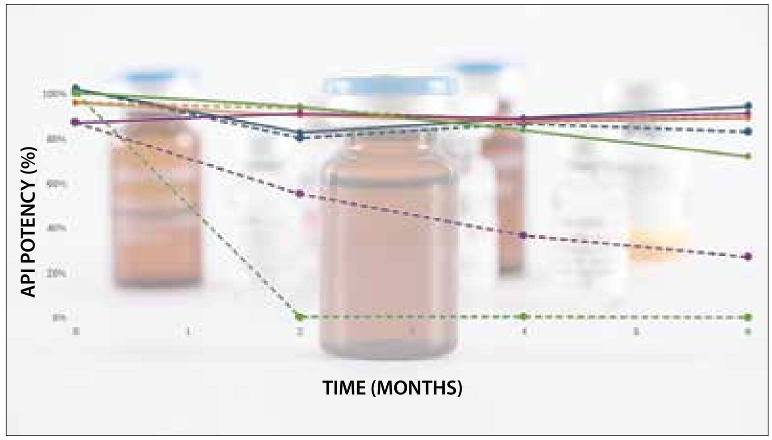

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SwRI evaluated NASA's medication handling practices, comparing medications stored in their original packaging (solid lines) to those repackaged for spaceflight in zip-style bags (dotted lines), finding that active ingredients degraded measurably when repackaged.

STUDYING MEDICINE STORAGE IN SPACE

SwRI evaluated NASA's medication handling practices, which currently call for removing drugs from their original packaging and storing them in resealable plastic bags. Although this allows astronauts to economize stowage for spaceflight, SwRI's investigation found that active pharmaceutical ingredients degrade at a higher rate when stored in bags.

NASA's Artemis program seeks to develop a lunar base to support a sustained human presence on the Moon. To prepare for longer space missions, SwRI collaborated with NASA to understand how active ingredients in medications may degrade over time.

Researchers did not fly any medicines into space but instead tracked and measured active ingredients found in common drugs that lunar astronauts would need. Researchers kept a sample of medications in their original packaging and repackaged other samples in zip-style plastic bags. They then exposed both sets of samples to hot, humid conditions — 40° Celsius/104° Fahrenheit and 75% relative humidity.

"While the study was limited to Earthly conditions, we found that within two months, active ingredients in one common antibiotic were completely degraded while ingredients in two other medications degraded measurably," said Judy Herrera, a senior research scientist at SwRI.

SwRI scientists performed periodic high-performance liquid chromatography analyses on the medicines over six months. Although the research was limited to a small sample of medications and did not account for space conditions, such as radiation, scientists noted significant degradation of active ingredients for the medications tested.

"SwRI's fully integrated pharmaceutical development program has the facilities, analytical expertise and experienced staff to design and execute studies like this efficiently, all within a single organization," said Darrel Johnston, director of Pharmaceuticals and Bioengineering at SwRI.

EBOLA VIRUS ADVANCES

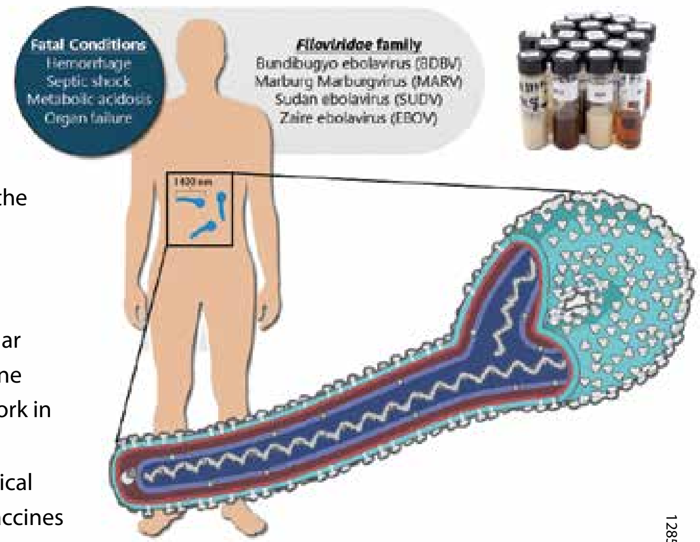
Recent advances in artificial intelligence have enabled SwRI to identify nearly two dozen antiviral compounds that could potentially treat Bundibugyo, a rare species of Ebola virus, currently affecting the Democratic Republic of Congo.

According to the World Health Organization, 516 suspected cases and 33 confirmed cases of the disease caused by the Bundibugyo ebolavirus have resulted in as many as 133 deaths. Bundibugyo virus, named for a region in Uganda where the species was first identified in 2007, kills up to 40% of infected people.

"We stand ready to support the biomedical community with rapid research and development of antiviral drugs as global health professionals respond to the latest outbreak," said Dr. Jonathan Bohmann, lead developer of SwRI's Rhodium™ molecular docking software designed to virtually screen drug compounds. "Our AI and machine learning tools help to quickly identify drug candidates that are the most likely to work in not only a high-value biocontainment environment but also in the human body."

The SwRI research is part of a decade-long collaboration with the Texas Biomedical Research Institute (Texas Biomed) where SwRI designs and formulates candidate vaccines and antivirals that Texas Biomed tests on live viruses in its state-of-the-art Biosafety Level 4 Laboratory.

The Ebola virus is rare with occasional outbreaks in equatorial Africa often linked to native fruit bats. SwRI and Texas Biomed began collaborating on Ebola virus research in 2016 with a contract award from the Defense Threat Reduction Agency.



128552

SwRI has identified nearly two dozen antiviral candidates to screen against the Bundibugyo species of the Ebola virus, part of the Filoviridae family illustrated. These deadly hemorrhagic fever viruses cause bleeding, septic shock, metabolic acidosis and organ failure over the course of infection.

DEEP-SEA LABS UPGRADED

SwRI's new 30-inch pressure vessel accommodates testing at pressures up to 16,500 psig, simulating the deepest ocean regions. It takes roughly two minutes to open or close, compared to the 30-45 minutes required by similar vessels.

128541

SwRI has upgraded its Ocean Simulation Laboratories with a new 30-inch-diameter pressure vessel. This new facility allows SwRI to test larger equipment at conditions that simulate full-ocean depth and features a novel SwRI-designed quick-acting closure.

Testing underwater equipment is necessary to ensure it can withstand the extreme conditions found at ocean depths, but conducting these tests in the ocean can be a lengthy, dangerous and costly process. SwRI has offered deep-ocean simulation testing services to the offshore oil and gas and marine industries for more than 60 years in its 18,000-square-foot Ocean Simulation Laboratories.

SwRI has expanded its already wide-ranging testing capabilities with a new 30-inch-diameter, 15-foot-deep pressure vessel. The cutting-edge vessel can test equipment and ocean vessels at up to 16,500 psig, simulating the pressures that equipment will experience in the deepest parts of the ocean.

"This pressure vessel offers several key advantages," said Paul Garza, who manages SwRI's Ocean Simulation Laboratories. "While other chambers take 30 to 45 minutes to open or close, SwRI's new design slashes that time to roughly two minutes. This allows for a much quicker turnaround between tests."

SwRI's vessel closure design makes misalignment, a common issue that can compromise safety, essentially impossible. The closure also has modular pass-throughs for electrical and other connections to items under test, which makes reconfiguration, replacement and maintenance of those parts much easier and faster.

"We've seen quick-acting closures before but never for vessels of this size that operate at such high pressures," said Kyle Robinson, who led the vessel design. "The vessel is designed for safety and durability. Our fatigue calculations show that it will be 20 years before it's necessary to inspect for cracks."

128547

NEW VERSION OF NPSS® SOFTWARE RELEASED

SwRI, on behalf of the Numerical Propulsion System Simulation (NPSS®) Consortium, has released a new version of the NPSS software, the industry-leading aerospace software package for simulating and designing propulsion systems. NPSS 3.3 adds new functionalities, data types and communication interfaces that provide improved flexibility and software compatibility while reducing model and component development times.

NPSS allows the aerospace industry to model turbomachinery, air-breathing propulsion systems, liquid rocket engines, engine control systems, and systems integration. It also supports modeling for refrigeration cycles, multi-phase heat transfer systems, vehicle emission analyses, supercritical carbon dioxide (sCO_2) power cycles, and more.

NPSS was developed in the 1990s by NASA's Glenn Research Center. Since 2013, SwRI has managed the NPSS Consortium to support the user community with new software capabilities, improved usability, and technical support. NPSS supports numerous applications ranging from creating new engine models to developing digital twin models of spacecraft. Beyond aerospace applications, NPSS has been used to simulate solar power systems, industrial gas turbines and hybrid electric systems.

Key features of NPSS 3.3 include electric port support that allows users to model hybrid turbo-electric propulsion systems, including electric vertical takeoff and landing systems. Complex numerical functions enhance electric system modeling, allowing users to tackle hybrid propulsion problems more effectively.

"NPSS incorporates the Functional Mock-up Interface industry standard, allowing NPSS to interface with other engineering tools," said SwRI's Griffin Beck, who oversees the NPSS consortium. "For example, a gas turbine performance model created in NPSS can now communicate with an external engine control model, enabling co-simulations that combine performance and external control models at the same time."

NPSS 3.3 features a foreign function interface (FFI) to allow integration with specific external functions rather than full software packages.

"The FFI provides users with greater flexibility and enables more detailed modeling," Beck explained.

128538

NEW CLINICAL SUPPLY FACILITY

SwRI recently celebrated the grand opening of its new Clinical Supply Facility (CSF). The 21,000-square-foot laboratory adds dedicated suites and HEPA filtered cleanrooms to support pharmaceutical development and bioengineering research, particularly in advanced clinical supplies. The facility expands SwRI's capability to conduct "Fill Finish" for capsules, sachets, tablets and other advanced formulations for all routes of administration. The facility will facilitate the production of active pharmaceutical ingredients, formulated products, and biologics or cell-based materials such as in vitro generated stem cells and vaccine components.

"By expanding our biomedical footprint, SwRI reinforces our role as a leader in pharmaceutical development and bioengineering in San Antonio's dynamic biomedical community," said Darrel Johnston, director of Pharmaceuticals and Bioengineering at SwRI. "This means faster access to clinical supplies for startups, universities and biotech companies not only in our local community but nationally and globally as well."

The facility will streamline workflows to support everything from regenerative medicine to vaccines, small-molecule therapeutics and treatments for rare diseases. Goals for the new CSF include improved regulatory efficiency, refined quality systems and increased communication between scientists for faster turnaround times. The CSF will reduce physical bottlenecks by serving as a one-stop shop for clinical supplies. It will include 4,200 square feet of ISO-rated production space along with 2,700 square feet of analytical support laboratories.

"Advancing a drug substance or drug product into clinical trials requires scalable, reproducible processes, rigorous analytical control and strict Current Good Manufacturing Practices (CGMP) compliance. The biggest challenge is maintaining quality and momentum as programs transition from research to regulated manufacturing," said Dr. Joe McDonough, vice president of Chemistry and Chemical Engineering at SwRI. "By integrating CGMP suites, cleanrooms and analytical labs into a single, purpose-built space, we can not only help our clients overcome those challenges, but we can also speed up processes and improve quality."

UPCOMING

WEBINARS, WORKSHOPS and TRAINING COURSES HOSTED by SwRI:

NASGRO Training Courses, August 4, 2026, virtual

Industrial Gas Turbine Combustion, August 5, 2026, virtual

Blade Aeromechanic Analysis, August 19, 2026, virtual

Keeping Score on the Shop Floor, August 26, 2026, San Antonio

Dry Gas Seals and Sealing Systems, September 9, 2026, virtual

Rotordynamics Tutorial, September 30, 2026, virtual

Lean Manufacturing Certification Program, October 1, 2026, multiple locations

TRADESHOWS:

Military Health System Research Symposium (MHSRS), Kissimmee, FL, August 3, 2026

Tinker and the Primes, Midwest City, OK, August 4, 2026

Australian Defence Science, Technology and Research (ADSTAR) Summit, Adelaide, SA, Australia, August 4, 2026

National Strength & Conditioning Association (NSCA) Tactical Annual Training, Orlando, FL, August 18. 2026

Small Satellite Conference, Salt Lake City, August 23, 2026

North American Sustainable Aviation Fuel (SAF) Conf & Expo, Tacoma, WA, August 25, 2026

Turbine Engine Technology Symposium (TETS), Dayton, OH, August 31, 2026

Texas Groundwater Summit, San Antonio, September 1, 2026

Turbomachinery & Pump Symposia, Houston, September 22, 2026

SAE Commercial Vehicle Engineering Congress (COMVEC), Chicago, September 29, 2026

GMRC Gas Machinery Conference, Indianapolis, October 4, 2026

CPRIT Innovations VII: The Cancer Prevention and Research Conference, Galveston, TX, October 5, 2026

Hydrocarbon Processing international Refining and Petrochemical Conference (IRPC), Houston, October 8, 2026

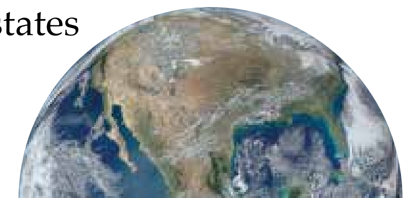
Association of the United States Army (AUSA) Annual Meeting and Exposition, Washington, DC, October 12, 2026

ASNT Annual Conference, Columbus, OH, October 12, 2026

BY THE NUMBERS
March 2026 — July 2026

47 presentations conducted in

14 states



& 6 COUNTRIES

41 papers published in

31 DIFFERENT PUBLICATIONS

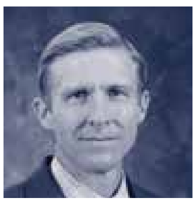
2 patents awarded


128515

San Antonio Mayor Gina Ortiz Jones asked SwRI President and CEO **Adam Hamilton** to serve on the Economic Security Advisory Group (ESAG). The group will advise the mayor about opportunities and strategies to make San Antonio more competitive in artificial intelligence, quantum technology, biotechnology and space manufacturing.


128570

The Society of Research Administrators International selected **Dr. Robin Ingerick** as a Fellow for the Journal of Research Administration's Author Fellowship Program through the Society of Research Administrators International. Ingerick joined SwRI in 2014 and currently serves as a senior manager of the Subcontracts and Program Compliance Groups within SwRI's Purchasing Department.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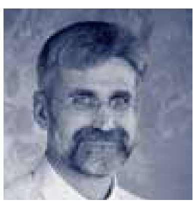
The American Society of Mechanical Engineers (ASME) selected **Dustin T. Osborne**, a staff engineer in the Powertrain Engineering Division, as a Fellow. A locomotive emissions expert, Osborne conducts performance testing of diesel and alternative-fueled locomotive platforms.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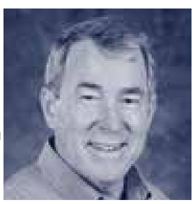
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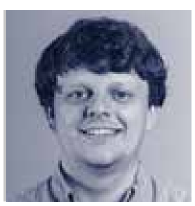
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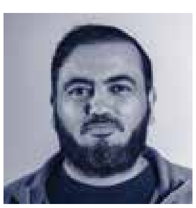
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Hantouli


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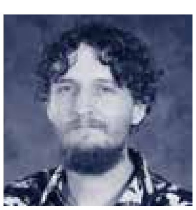
Herrmann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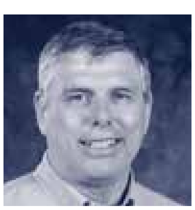
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Schnelle

The Dixie Crow Chapter of the Association of Old Crows (AOC), an international organization for the electronic warfare (EW) community, is honoring eight SwRI staff members for their contributions to EW advances and innovations. They will receive awards at the annual Dixie Crow Symposium on March 24, 2027, in the Scott Theatre, Museum of Aviation, at Robins Air Force Base in Georgia.

Principal Computer Scientist **Michael Day** will receive the Distinguished Service Award for dedicating 42 years to advancing EW. **Keith Dufford**, manager of the Spectrum Assurance Section, will receive the Business Management Award for demonstrating exceptional leadership and strategic vision. Research Engineer **Nicholas Fauble** will receive the Software Award for exceptional contributions to mission-critical software. Senior Research Engineer **Will Glover** will receive the AOC Joseph W. Kearney Pioneer Award for leading groundbreaking research advancements. Senior Research Engineer **Fadi Hantouli** will receive the AOC Academic and Educational Excellence Award for exceptional academic rigor and innovation. Research Engineer **Nick Herrmann** will receive the Radio Frequency Award for outstanding achievement in advanced Radio Frequency. Senior Research Engineer **Luke Pratt** will receive the Research and Development Award for groundbreaking advancements in neuromorphic signal processing. Staff Engineer **Christopher Schnelle** will receive the AOC Anton D. "Tony" Brees Lifetime Service Award for 40 years of technical excellence in EW engineering and software development.

TECHNOLOGY **TODAY**

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