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advances WALES

Melting glaciers – drilling down into the detail

Scientists from Aberystwyth University aim to drill into the upper Khumbu Glacier and use boreholes to record temperature data. This data will help them identify evidence of melting and refreezing within the glacier's surface snowpack.

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Welcome to Issue 104 of Advances Wales, a special edition leading with innovations driving sustainability and addressing climate change. This issue also highlights projects aligned with the other Welsh Government's Innovation Strategy Missions, education, economy, health and wellbeing.

Our lead article examines the melting glaciers of the Himalayas, where rising temperatures and solar radiation threaten water supplies for over a billion people and increase the risk of catastrophic floods.

In Wales, efforts are transforming the industrial legacy of coal mining into a renewable energy opportunity by harnessing geothermal energy from flooded mines to heat homes and businesses. While a team from Swansea University is advancing the safety and performance of lithium-ion batteries—key to renewable energy and electric transportation.

Bangor University and The Mount Elgon Tree Growing Enterprise (METGE) are promoting sustainable agroforestry and reducing plastic waste, contributing to reforestation and climate resilience.

On the digital frontier, a Swansea University-led team has developed Gross National Happiness. Today, an AI tool providing real-time national happiness insights, revolutionising how well-being intersects with environmental and social factors.

Other highlights include breakthroughs in green hydrogen production, faster imaging techniques for microscopy, and Cardiff University's discovery of a drug with the potential to transform treatment for early-stage type 1 diabetes. We also explore mantle-derived rocks offering insights into Earth's origins and Bangor University's work uncovering undiscovered global fungi species, underscoring biodiversity's untapped potential.

These stories celebrate the spirit of Welsh innovation, offering solutions to global challenges while inspiring a sustainable future.

Gwyn Tudor
Editor

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Advances Wales is a quarterly technology journal produced by Welsh Government to showcase new developments in science, engineering and technology from Wales. Advances raises the profile of the technologies and expertise available from Wales in order to facilitate collaborative relationships between organisations and individuals interested in new technologies and innovation.

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Project will Create 'Homes as Power Stations' Demonstration Houses

A partnership between Neath Port Talbot Council, Tai Tarian, and Cardiff University aims to inform and inspire industry and residents to support the use of technology to create cleaner, greener, energy-efficient homes.


Credit: Neath Port Talbot Council

Two homes have been selected to showcase the latest solutions. They will benefit from measures such as insulation and PVC windows, as well as technology including solar panels, battery storage, and air source heat pumps.

The Homes as Power Stations (HAPS) demonstration houses will provide a place for people to visit, interact with, and learn about the operation of these cutting-edge technologies. They will also serve as a way to connect with installers and contractors who are working in, or considering entering, this field.

The homes will enable essential knowledge to be shared about reducing a home's dependency on fossil fuels and energy networks. These improvements will make homes warmer and less expensive to run, thereby addressing fuel poverty and offering environmental and health benefits. The houses will be designed to showcase each step of the improvement process, highlighting the skills and technology required to achieve maximum benefits.

"We are looking forward to implementing new green technology as part of this project, ensuring our tenants have guidance on using such systems allowing them to maximise their energy savings, improving the comfort of their home and reducing their carbon emissions."
Craig Mayberry Thomas
Tai Tarian

www.taitarian.co.uk

How solar power and farming can coexist

Researchers at Swansea University have developed an innovative software tool designed to identify the optimal photovoltaic (PV) materials to enhance crop growth while simultaneously generating solar energy.

The work focuses on the effects of semi-transparent PV materials that can be placed over crops. This approach, known as agrivoltaics, combines agriculture with solar energy production. It involves installing solar panels over farmland or integrating them into agricultural practices, enabling the simultaneous production of food and renewable energy.

The newly developed tool can predict the performance of various PV materials in almost any location worldwide, evaluating how they transmit and absorb light, as well as how much power they generate. The technology provides researchers with a novel method to compare different materials and determine the best option for balancing food production with renewable energy generation.

By using PV materials that allow certain wavelengths of light to pass through, crops can still receive the sunlight they need for photosynthesis while benefiting from the energy generated by the solar panels.

Selecting the appropriate PV material is crucial for optimising agrivoltaics, as it affects how different wavelengths of light are absorbed. Materials with a wider bandgap absorb higher-energy, shorter-wavelength light (such as blue), while those with a narrower bandgap absorb lower-energy, longer-wavelength light (such as red). By carefully selecting PV materials with specific bandgaps and absorption characteristics, it is possible to optimise the colour of light transmitted through semi-transparent solar panels to benefit crops. Most plants primarily absorb red and blue light for photosynthesis, while reflecting green light. This fine-tuning ensures that crops receive the necessary wavelengths for optimal growth while enabling effective solar energy production.

Solar panels or PVs can be integrated into agricultural settings in various ways, such as being installed on the roofs of greenhouses or used as shelters for livestock, allowing for local energy generation with minimal disruption to farm output. This integration can also reduce maintenance costs, as livestock can graze on vegetation around the panels. However, careful selection of livestock is essential, as some animals, like goats, may jump on the solar panels and cause irreversible damage.

The research aims to reduce carbon emissions in the agricultural sector while generating clean energy and enhancing food security, promoting a sustainable and resilient farming system.

Austin Kay, Swansea University, said: "This technology, which allows us to compare many types of PV material, could help us determine how we balance food production and renewable energy generation."

www.swansea.ac.uk

Surgeons cut carbon emissions at North Wales hospitals

Two surgeons from North Wales, Preetham Kodumuri and Edwin Prashanth Jesudason, have been recognised for their sustainability efforts in healthcare. Their innovative project has earned them the Professor Sir Mansel Aylward Innovator Award from the health and care think tank The Bevan Commission. The initiative achieved an 88% reduction in carbon emissions and cut departmental costs by two-thirds.

The project was part of the Green Surgery Challenge, a collaboration with the Royal College of Surgeons and the Centre for Sustainable Healthcare. The surgeons redesigned carpal tunnel release surgical procedures by implementing a 'lean and green' approach to streamline processes and reduce waste.

A key change involved reducing the number of sterile instruments in the procedure pack from 30 to just seven, significantly lowering re-sterilisation costs per pack. Additionally, the weight of waste generated per procedure pack dropped from 3.5kg to 1.2kg. Operating theatre drapes were downsized to cover only the hand area, cutting unnecessary material use.

In addition, by relocating minor procedures from operating theatres to outpatient clinical rooms, the team further reduced the hospital's carbon footprint and energy consumption. Operating theatres, account for 20-30% of a hospital's waste and energy use.

"As surgeons, we must acknowledge the environmental impact of our practices and take steps to mitigate it. By making small but thoughtful changes, such as reducing single-use items, we've demonstrated how significant improvements can be achieved for both the environment and healthcare systems."

Mr Kodumuri
North Wales Surgeon

Mr Jesudason added: "Our success so far has inspired us to take further action. We now have minor hand surgery procedure rooms out of main theatres and in an outpatient environment. This allows us to further reduce our carbon footprint and generate additional cost savings while maintaining a high level of care.

www.bevancommission.org

The psychology behind extreme sports participation

A study conducted at The University of South Wales is challenging traditional views of what motivates individuals to engage in extreme sports.

While participants are often portrayed as thrill-seekers driven by adrenaline, this research reveals a more intricate psychological landscape.

The work was carried out by Odette Hornby, a PhD candidate in sport psychology and an avid climber. She explains - "Extreme sports are incredibly subjective. What feels risky to one person may feel safe to another, based on their skills and experiences." This study identifies five key motivational factors that paint a more nuanced picture of extreme sports athletes:

Existential and External: Many participants describe a profound connection with nature, a sense of liberation from daily life, and the desire to push their limits while fostering a sense of community.

Personality: While some athletes exhibit sensation-seeking traits, Hornby found that extreme sports often serve as a medium for emotional expression and regulation. This is especially significant for those with alexithymia, a difficulty in identifying and articulating emotions.

Motivational Characteristics: Athletes are driven by goal achievement, confidence in their abilities, and the determination to overcome obstacles. The sense of control and belonging within a community are also pivotal.

Managing Risk: Risk perception and management are central. Some athletes thrive on the excitement of dangerous situations, perceiving them as exhilarating rather than fear-inducing.

Analogies with Addiction: Certain participants report mood disturbances, such as boredom or unhappiness, when not engaged in extreme sports, echoing the withdrawal symptoms seen in addiction.

These findings have practical implications, suggesting that extreme sports may be therapeutic for those struggling with emotional regulation.

www.southwales.ac.uk

IN BRIEF

Welsh carbon capture technology

An innovative enclosed engine system developed in North Wales by Robert Lim Inventions Ltd, captures carbon dioxide while generating electricity, providing an efficient and cost-effective solution for large-scale emissions reduction. This approach aligns with global decarbonisation targets as governments pursue practical carbon capture strategies. The renewable energy-powered system uses a unique process: air is driven into a liquid-filled tank using bellows, which turn paddles to produce electricity, stored in a battery. Carbon dioxide is absorbed into the liquid medium using a "sticky liquid chemical" process, releasing clean air. The liquid absorbs CO2 until saturation. When saturated, a heating process releases the CO2, transferring it to a secondary tank for industrial use or sequestration. The project is supported by Bangor University's Nuclear Futures Institute, where the team is conducting tests to validate the system's effectiveness.

Preserving Welsh and English voices

Welsh speakers at risk of losing their voice due to medical reasons can now continue communicating in their language, thanks to an innovative programme. The Lleisiwr programme, developed by Canolfan Bedwyr at Bangor University, allows users to bank their voices and create personalised synthetic versions. Previously, voice banking services were only available in English, but this new technology caters to both Welsh and English speakers. Lleisiwr provides vital support for those facing the distressing loss of their natural voice, enabling them to communicate using a synthetic voice that sounds like their own. Gruffudd Prys, from Bangor University, highlighted the importance of this development: "We tend to switch back and forth between our languages throughout the day. You shouldn't need to change your software every time you want to change your language."

Innovative VR meditation enhances broadcast team productivity

A tech start-up has introduced VR meditation sessions to support the staff who worked on delivering coverage for the Paralympic Games. More than 200 production staff at the Cymru Broadcast Centre in Cardiff participated in these immersive sessions, delivered by Welsh company Virtus Tech and designed to alleviate the stress and pressure of creating over 1,300 hours of live content. Using the company's advanced VR platform the sessions offered short, guided meditations during breaks from production. These meditative experiences aimed to reduce stress, enhance focus, and improve overall well-being, providing respite for staff engaged in high-pressure, fast-paced work. The results were very positive: more than 75% of participants reported feeling well-prepared and mentally clear to return to their tasks after each session. Additionally, over 90% expressed a desire for regular VR meditation breaks as part of their daily routine. This innovative use of VR technology demonstrates how immersive tools can be integrated into demanding work environments to boost productivity and mental health.

Revolutionising composites: embedded flat fibre sensors

Wrexham University is working on a £2.2 million project, in collaboration with the University of Southampton, to explore how flat optical fibre sensors could revolutionise the manufacturing of high-value composite materials. Composites, made by combining materials like plastic, carbon fibre, and glass, are used in aircraft, cars, wind turbine blades, and bridges because they are lightweight, strong, and durable. Flat fibre sensors could be embedded within composites to monitor their integrity and strength during use. This technology may also enhance manufacturing processes, optimise component performance, and predict potential failures, significantly improving the efficiency and safety of composite structures. Professor Richard Day at Wrexham University, said: "The ability to make and employ fibre optic sensors, which are capable of having directional sensing opens up huge areas of understanding in composites and beyond."

Centre for speech, hearing and communication research launch

Cardiff Metropolitan University has launched a new research centre which specialises in research on speech, hearing and communication. The Centre brings together expertise in three major areas of research, including clinical speech and language therapy research; healthy and impaired hearing; and bilingual and multilingual development. The clinical speech and language research is run in partnership with the Bristol Speech and Language Therapy Research Unit (BSLTRU). Much of the research involves national and international collaborations, notably with universities in Europe, the USA, China, Japan and Australia. Vice-Chancellor and President, Professor Rachael Langford, who attended the launch event, said: "The work at the Centre is very much clinically applied and aims to make a real difference to service users, ensuring the services they receive are effective, efficient and informed by evidence from high-quality research."

Health board project cracks CO^2 emissions

Cardiff and Vale University Health Board has introduced technology aimed at making the use of 'gas and air' pain relief safer for the environment. Entonox, a mix of nitrous oxide and oxygen, is commonly used for pain relief during labour but contributes significantly to climate change when exhaled. It accounts for approximately 75% of carbon dioxide equivalent emissions from anesthetics across the health board. A new machine, known as a nitrous oxide "cracker," has been installed in the University Hospital of Wales' maternity unit. This device breaks down exhaled nitrous oxide into nitrogen and oxygen, reducing harmful emissions while maintaining effective patient care. The initiative has been well-received by healthcare staff and patients. The project was driven by a multidisciplinary team, inspired by the Health Board's Spread and Scale Academy. It forms part of broader efforts by Cardiff and Vale UHB and NHS Wales to promote sustainable healthcare practices, with hopes of wider implementation.

Welsh collaboration on Space Nuclear Power

The Rolls-Royce National Space Innovation Programme is advancing the development of micro-reactor technology to support future space missions. Working with academic partners from the University of Oxford and Bangor University, the project focuses on developing the complete system design, core capabilities, and key technologies needed for space nuclear power. This programme aims to position the UK as a leader in the emerging space nuclear power market, showcasing its readiness to advance towards detailed designs. A demonstration flight is expected by the end of this decade. Reliable power and propulsion are critical for achieving global ambitions in space exploration. Current power sources, such as solar, have limitations that pose operational challenges. Nuclear fission technology is widely regarded as the solution, particularly for enabling sustained activity on the Moon. Operating independently of sunlight, the micro-reactor offers a resilient and persistent power source for long-term exploration and scientific missions.

Wearable technology and AI for community-based healthcare

Virtual Ward Technologies Ltd (VWT), a Welsh health tech company, delivers data-driven, community-based healthcare solutions by combining wearable technology with AI-powered platforms. This approach enables continuous patient monitoring at home, helping to reduce hospital admissions and improve resource allocation across healthcare systems. By using advanced sensor technology, VWT provides real-time health data to monitor users' health and wellbeing. Regular updates allow potential health issues to be identified early, enabling patients and carers to take action to prevent problems or address them before they worsen. This approach integrates personalised care into diverse settings, from urban hospitals to rural communities. It supports the delivery of efficient, effective healthcare, addressing growing challenges in patient management and resource utilisation.

New framework for microbial communities

A new framework has been developed by scientists at Swansea University, working with international partners, to help researchers understand how microbial communities form and interact with multicellular hosts. The research combines ecological and evolutionary theory to explore how host-associated microbiomes emerge in nature. The framework is being used to study microbial communities in marine sponges, with plans to extend the findings to other microbiomes. This work aims to create a unified understanding of symbioses across different species and host groups. Dr Lurgi at Swansea University explains: "Our research aims at bringing together ecological and evolutionary theory on one hand, and microbial and symbiont ecology and evolution on the other, to create a holistic picture of the assembly of complex symbioses. These ancient symbiotic relationships are fundamental to the survival of both hosts and microbes."

Biomedical training through VR

Research shows that Virtual Reality (VR) platforms can increase workplace confidence by up to 40%, accelerate training completion by up to four times, and improve both training and on-the-job focus by a similar margin. Welsh tech company Clear Pixel VR is reshaping biomedical education with its immersive virtual reality (VR) technology. By recreating real-world environments, their innovative training tools provide hands-on experience with laboratory procedures, bridging the gap between theoretical learning and practical skills. The company's VR platform offers realistic training scenarios, enabling students and professionals to practise complex lab techniques safely and effectively. This approach enhances learning outcomes and better prepares users to tackle the challenges of biomedical research and clinical practice. Traditional training methods, often reliant on outdated paper-based approaches, are seen as a major barrier to innovation. Employers and universities report that practical neuroscience training is sporadic, inefficient, and generates significant waste.

Melting glaciers - drilling down into the detail

Changes in the rate of glacier melting in the highest mountains of the Himalayas could jeopardise a critical sources of water for over one billion people.

Glaciers in the highest mountains of the Himalayas are critical sources of water for over one billion people, including many in India, Pakistan, and Bangladesh. Changes in the rate of glacier melting could jeopardise this water supply and increase the risk of flooding through the failure of natural ice dams, known as Glacial Lake Outburst Floods. Despite air temperatures being well below freezing, the snow on Mount Everest, Earth's highest mountain, may be melting due to rising air temperatures and intense solar radiation.

A team from Aberystwyth University and the University of Leeds is leading an expedition to the Western Cwm, located over six kilometres above sea level and half a kilometre above Everest Base Camp. During their first expedition, planned for spring 2025, they aim to drill into the upper Khumbu Glacier and use boreholes to record temperature data. The team will also set up automatic weather stations at study sites. This data will help them identify evidence of melting and refreezing within the glacier's surface snowpack. The project builds on previous research that revealed ice temperatures in the lower Khumbu Glacier are higher than expected based on local air temperatures.

Due to the logistical challenges of transporting equipment, scientific observations at such high altitudes are rare. To overcome these difficulties, the team is designing a lightweight drilling setup, though they will still face challenges such as maintaining battery power in freezing temperatures and working in harsh conditions with low oxygen levels. The researchers say that successfully drilling even a single borehole within the Western Cwm would be a significant achievement, enabling them to model changes in water supplies for a large part of the world's population with greater accuracy.

The project aims to enhance understanding of the processes affecting glaciers in similar environments worldwide. The team hopes to contribute to ongoing debates about net mass loss at high altitudes and assess whether other Himalayan glaciers also contain unexpectedly warm ice.

The team believes that their insights into this rarely observed cryospheric zone (areas of the Earth where water is frozen) can help inform public policy on climate change and assist the region in adapting to changes in meltwater supply caused by shifting climatic conditions.

View from Mount Everest base camp, Khumbu icefall, Western Cwm

"It may well be a bit of a surprise to many that snow is melting within the mountain's Western Cwm, but it is increasingly likely and it needs to be investigated and measured if we are going to be able to identify the effects of climate change on this water-stressed region and beyond. Understanding and recording what actually happens inside these glaciers is critical to developing computer models of their response to anticipated climate change. Equally important is developing a better understanding of how they flow so that we can better predict when dams that form on these glaciers are likely to be breached, releasing destructive volumes of water to the valleys below. This is a real risk in the Himalayas as it is in other regions such as the Andes and has the potential to endanger the lives of thousands of people."

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ABERYSTWYTH

Wales' coal mines could heat homes again

Wales has a rich history of coal mining, but as the country transitions towards greener, more sustainable energy sources, this industrial legacy could become a valuable resource for renewable energy.

After decades of mining, a vast network of underground workings remains, most of which are now closed and flooded. These abandoned mines, filled with water, present a unique opportunity for sustainable energy production. The heat trapped in these waters can be harnessed to provide space heating for homes, businesses, and larger heating networks.

A new open access map, created by the Coal Authority, pinpoints areas across Wales with the greatest potential for mine water heat schemes. This tool is designed to identify locations where this low-carbon solution can be most effectively implemented, supporting the national effort to decarbonise heating.

Areas are highlighted where mine water heat recovery could have a significant impact. It is accompanied by a series of open-access reports detailing the best opportunities within each local authority in Wales. These resources are intended to help both the public and private sectors assess the viability of mine water as a renewable heating source for new or existing developments, whether residential, commercial, or industrial.

The work is the result of extensive research, which involved evaluating all known coal mine workings in Wales. The project took over a year to complete, providing a comprehensive overview of potential sites where mine water heat could be utilised.

In South Wales, historically one of the largest coal mining regions, the map identifies several promising areas for potential mine water heat schemes. These areas are ranked based on the feasibility of the schemes, from good to possible to challenging. For sites with high potential, there are two main ways to access the heat: through purpose-drilled boreholes into the mine workings or by tapping into existing mine water treatment schemes, which already bring water to the surface.

The research found that almost 20% of homes in Wales are located within the three opportunity areas. This suggests that a significant portion of the population could potentially benefit from this innovative heating solution.

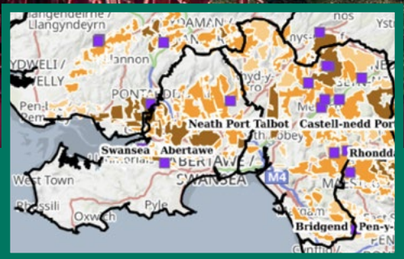
The map also highlights opportunities in North Wales. Technical experts considered several factors when developing the opportunity maps, including the depth of underground workings, current mine water levels, and evidence of opencast mining activities. Each area was categorised as "good," "possible," or "challenging," reflecting the varying levels of opportunity for developing mine water heat schemes.

Additionally, the map identifies existing Coal Authority mine water treatment sites. These sites already pump water to the surface as part of ongoing environmental management efforts which treat 16 billion liters of water, preventing 378 tonnes of iron solids from entering Welsh rivers every year. Heat recovery technology could be adapted at these sites to harness the water's heat for local heating schemes.

As Wales explores the potential for mine water heat schemes, the open-access map serves as a valuable tool for both government and private organisations to make informed decisions. With growing pressure to reduce carbon emissions and the increasing need for renewable energy sources, mine water heating could play a significant role in delivering Welsh Governments Heat Strategy. The Coal Authority are working with stakeholders across south Wales and hope that the first mine water heat scheme in Wales will be operational in 2025.

Gareth Farr, head of the mine water heat team at the Coal Authority, expressed optimism about the project. "We're really excited that the open-access map will support organisations considering mine water as part of their low-carbon heating solutions in Wales," he said. "Repurposing our industrial coal mining heritage to create a greener future is a brilliant opportunity."

The concept of recovering heat from mine water has been successfully implemented in other parts of the UK. One of the largest mine water heat networks in Europe is in Gateshead, in the northeast of England. Operating since March 2023, the Gateshead scheme provides secure, low-carbon heating to 350 homes, as well as various other buildings. The project's success has led to expansion plans, with future phases set to include 270 private homes, a new conference centre, and a hotel.



Click the link below to view the live Mine Water Heat Opportunity for Wales interactive map:

https://datamap.gov.wales/maps/mine-water-heat-opportunity-map-for-wales/view#/

Contact

Mining Remediation Authority

www.gov.uk/government/organisations/mining-remediation-authority

0800 288 4211

communityresponse@coal.gov.uk

CARDIFF

Improving battery safety with graphene

Welsh and Chinese scientists have created a safer, more efficient lithium-ion battery

Close-up of Lithium-ion High-voltage Battery Component

A team from Swansea University, in collaboration with Shenzhen University, has developed a method to improve the safety and performance of lithium-ion batteries, addressing a significant challenge in energy storage technology. Lithium-ion batteries are rechargeable power sources used in consumer electronics, laptops, mobile phones, and electric vehicles.

One of the primary concerns with high-energy lithium-ion batteries (LIBs) is the risk of thermal runaway, which occurs when a battery overheats, potentially leading to a chain reaction resulting in fires or explosions. This can happen due to manufacturing defects, physical damage, or external conditions, and is particularly critical in high-energy applications like electric vehicles.

The team has developed a scalable graphene current collector to tackle crucial thermal issues in lithium-ion batteries. Their work demonstrates the first successful approach to manufacturing graphene foil current collectors on a commercial scale. These foils play a vital role in the battery, supporting the anodes and cathodes. The new graphene foils exhibit remarkable thermal conductivity, reaching up to 1,400.8 W m−1 K−1 nearly ten times higher than copper and aluminium.

While copper and aluminium are standard materials for current collectors, they do not conduct heat as efficiently as graphene. The graphene current collectors are specifically designed to help reduce the risk of battery overheating by effectively dissipating heat and preventing the chemical reactions that can cause dangerous temperature increases.

The dense structure of graphene acts as a strong barrier against flammable gases and also prevents oxygen from entering the battery cells, which is crucial for avoiding serious malfunctions or failures.

The researchers have developed a process that can produce graphene foils in large lengths, ranging from metres to kilometres. For example, they successfully created a 200-metre-long graphene foil that is 17 micrometres thick. Impressively, this foil maintained its electrical conductivity even after being bent over 100,000 times, making it suitable for flexible electronics and other advanced applications.

This new method enables the production of graphene foils in various thicknesses, potentially leading to even safer and more efficient batteries. It has significant implications for the future of energy storage, particularly in electric vehicles and renewable energy systems, where safety and efficiency are critical factors.

"This is a significant step forward for battery technology. Our method allows for the production of graphene current collectors at a scale and quality that can be readily integrated into commercial battery manufacturing."

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SWANSEA

Biobased pots root out plastic waste in East Africa

Bangor University is working with The Mount Elgon Tree Growing Enterprise (METGE), to promote sustainable tree growing and reduce plastic waste in East Africa's agroforestry sector.

Supported by the "Wales and Africa" programme, METGE, a not-for-profit, non-government organisation based in Mbale, Eastern Uganda, manages and develops tree-growing enterprises that adhere to high environmental and ethical standards with an aim of distributing 25 million trees locally by 2025.

Currently, METGE, produces around 3.2 million tree seedlings each year, which are supplied in plastic potting bags made from fossil fuel-derived materials, including polyethylene. However, these bags cannot be reused or recycled, and there is no established method for their disposal, resulting in growing concerns over plastic waste. This issue is compounded by a broader problem with the use of agricultural plastic mulch films that present a significant environmental issue by causing soil contamination. To address both of these issues, the team has prioritised developing a more sustainable agricultural film for cultivating, transporting and supplying tree seedlings.

Bangor University and the National Agricultural Research Organisation (NARO) in Uganda have partnered with METGE to create a sustainable and biodegradable alternative to plastic potting bags called Biopots. The Biopots are produced from a range of agricultural crop residues created in Uganda. Researchers from Bangor University's BioComposites Centre have successfully produced extruded film samples which are made into Biopots, while the School of Natural Sciences has assessed their biodegradability and other properties.

In 2023, the project took an important step forward with the supply of rolls of the extruded film which were converted into the Biopots. These were evaluated at five nursery sites in Mbale. Unlike traditional, single use, plastics such as polyethylene, Biopots do not produce harmful microplastics as they degrade. Instead, they can potentially improve soil health by returning organic matter to the land as they decompose, creating an added environmental benefit.

An integral part of the project has been engagement with key stakeholders in Uganda. A series of workshops was held in Kampala and Mbale, bringing together farmers, growers, and representatives from local, regional, and national government agencies. The workshops were supported by media coverage, including television, radio, and press interviews with members of the project team, ensuring the message reached a wide audience.

The Biopots initiative is now extending its reach beyond Uganda. The team is working with Consultants in Kenya to establish connections with tree growers and nursery operators in the Kenyan part of the Mount Elgon region. The Kenyan Government has ambitious reforestation targets and plans to plant 15 billion trees over a ten-year period from 2022. Development of a more sustainable tree seedling pot will help reduce single use plastics waste associated with this programme.

In 2024, the project team expanded their focus by visiting coffee growers and tree nurseries in the Masaka region of Uganda to explore opportunities for using Biopots in other sectors.

Through innovative partnerships and stakeholder engagement, the Biopots project is paving the way for a sustainable future in East Africa by reducing plastic waste, supporting agroforestry, and improving soil health.

Biopots ready for planting

Community event with schoolchildren in Mbale

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BANGOR

Advances

Using AI to measure national happiness

Across the globe, artificial intelligence (AI) is being used in diverse and innovative new ways, including to measure national happiness in real time.

An international research team, led by Swansea University, has developed an AI tool known as Gross National Happiness.Today (GNH.Today), uses a novel method called crowdsensing to assess how happy a nation is. Unlike traditional approaches that depend on periodic surveys, this new approach provides a daily snapshot of national happiness.

Crowdsensing is a technique where a large group of individuals with mobile devices, capable of sensing, share data to measure, map, analyse, estimate, or predict processes of common interest. By relying on open, publicly available data, crowdsensing can ensure privacy and consent while delivering a comprehensive, real-time view of public sentiment, making it a valuable tool for understanding how people feel.

This is the first time crowdsensing has been used to measure national happiness without relying on data from social media platforms. Instead, it analyses emotion-related words from a variety of online sources, such as Google searches, to provide a more detailed and accurate representation of the national mood.

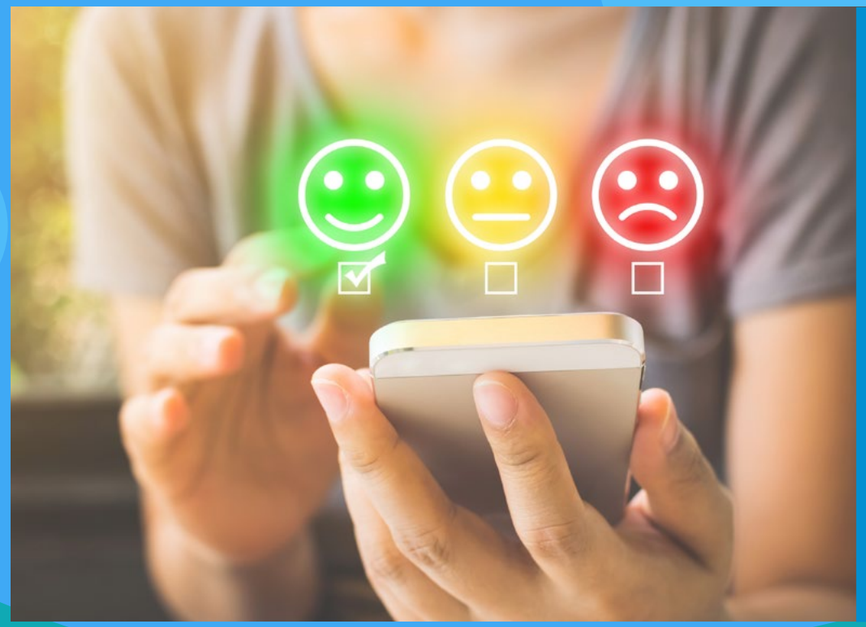
The tool promises to offer valuable insights into societal wellbeing worldwide. One significant advantage is the ability to offer immediate, dynamic data that can be crucial in rapidly changing contexts, such as political events. In contrast, traditional happiness surveys can take time to conduct and analysed, often resulting in outdated information by the time it is published.

The happiness index used by this new technology ranges from 0 (extreme unhappiness) to 10 (extreme happiness), presenting a fresh perspective on measuring and understanding societal well-being.

The researchers believe that it represents a significant leap in how we gauge societal progress. By harnessing open-source data, the tool promotes more empathetic governance, offering a clear and trustworthy measure of national happiness.

This shift could allow governments to concentrate more on how citizens feel, rather than relying solely on traditional economic indicators. As a result, the technology could serve as a valuable resource for decision-makers worldwide, helping them create policies that enhance quality of life.

Additionally, the tool could support humanitarian organisations to better understand and respond to the needs of a population.



"GNH.Today revolutionises how we understand societal well-being by offering real-time data, a critical tool for policymakers.

"The traditional metrics of national success, primarily economic indicators, have long been criticised for their inability to capture the true essence of human well-being. Over the past 50 years, Western nations have sought to address this gap through periodic happiness surveys. However, the rapid pace of modern life and the proliferation of mobile technology have rendered these slower methods less relevant. GNH. Today provides an immediate, dynamic assessment."

Dr Frédéric Boy
Project co-lead
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SWANSEA

University focuses on neutral atomic beam microscopes

Scientists from Swansea University have developed a new imaging method for neutral atomic beam microscopes to acquire images faster than current methods.

Neutral atomic beam microscopes work by directing a beam of low-energy neutral particles, typically helium atoms, at a surface. The particles scatter off the surface and can be used to create an image of its structure and composition.

These microscopes are currently a hot topic for research, as they can image surfaces that traditional commercial microscopes cannot, especially delicate samples like bacterial biofilms, ice films, or organic photovoltaic devices. These types of samples can be damaged or altered by conventional imaging methods that use electrons, ions, or photons.

However, one drawback of this method is the time it takes to create an image. Currently neutral atomic beam microscopes produce images by shining a beam through a tiny pinhole, scanning a sample one pixel at a time. If researchers try to improve the resolution by making the pinhole smaller, the number of particles available for imaging is reduced, further extending the time needed to make measurements.

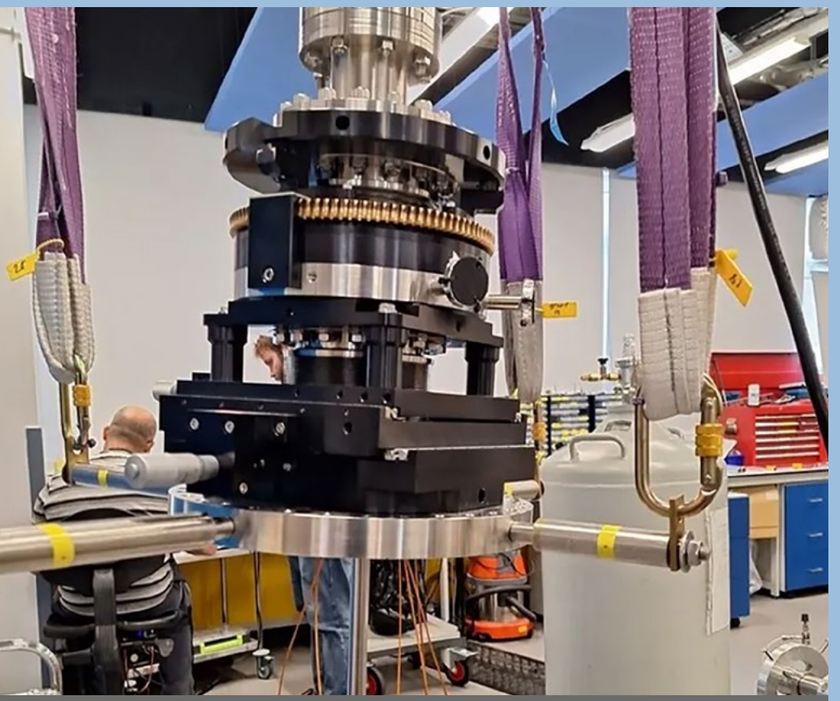
The new method uses a beam of helium-3 atoms, a rare light isotope of helium. By passing this beam through a non-uniform magnetic field and utilising nuclear spin precession, the technique encodes the positions of the beam particles as they interact with the sample. By observing these position changes, scientists can capture detailed information about the sample's structure, enabling them to form a faster and more accurate image.

> **"The method we have developed opens various new opportunities in the field of neutral beam microscopy. It should make it possible to improve image resolution without requiring forbiddingly long measurement times and has the potential for enabling new contrast mechanisms based on the magnetic properties of the sample studied. In the immediate future the new method will be further developed to create a fully working prototype magnetic encoding neutral beam microscope. This will allow testing of the resolution limits, contrast mechanisms and operation modes of the new technique."**
>
> **Professor Gil Alexandrowicz**
> Chemistry Department
> Swansea University

This version streamlines the language slightly for clarity while retaining the technical essence.

This new imaging method could lead to a faster alternative to pinhole scanning and could allow engineers and scientists to get quicker results when scanning samples.

This new type of imaging should eventually be available to scientists and engineers to characterise the topography and composition of sensitive and delicate samples.



The Swansea University neutral atomic beam microscope

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SWANSEA

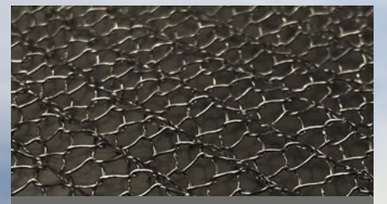
World's largest wire knitting machine for green hydrogen production

A leading manufacturer of knitted wire mesh products has invested in the world's largest wire knitting machine.

KnitMesh Technologies, headquartered in Flintshire, announced the move as a major milestone in their commitment to advancing green hydrogen production. This machine, capable of knitting mesh for electrolyser applications up to 4 metres wide, will be used to manufacture knitted wire mesh specifically designed for the production of green hydrogen from water.

Green hydrogen can be produced by splitting water (H_2O) into separate hydrogen and oxygen molecules using an electrolysis process. The hydrogen gas produced is a clean and sustainable energy source that can be used as an alternative to carbon-based fuels such as petrol, diesel, and natural gas. When used as a fuel in automotive applications, hydrogen emits only clean water from the tailpipe, making it an environmentally friendly option.

Over the past decade, KnitMesh Technologies has been developing innovative knitted wire mesh solutions for the green hydrogen industry. Their latest investment in what is the world's largest wire knitting machine, along with other bespoke equipment, including an array of specialist welding machines and laser cutters, will support the production of low-cost hydrogen fuels.



An example of KnitMesh technologies' Knitted Wire Mesh

> **"We see hydrogen fuel as a key component of a sustainable future. We are actively expanding our business through recruitment and new equipment, and we see a bright future for our hydrogen division."**
>
> **Peter Evans**
> Managing Director
> KnitMesh Technologies

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HOLYWELL

Psoriasis drug shows promise for childhood diabetes

A recent clinical trial led by Cardiff University has revealed that a drug commonly used for psoriasis may effectively treat the early stages of type 1 diabetes in children and adolescents.

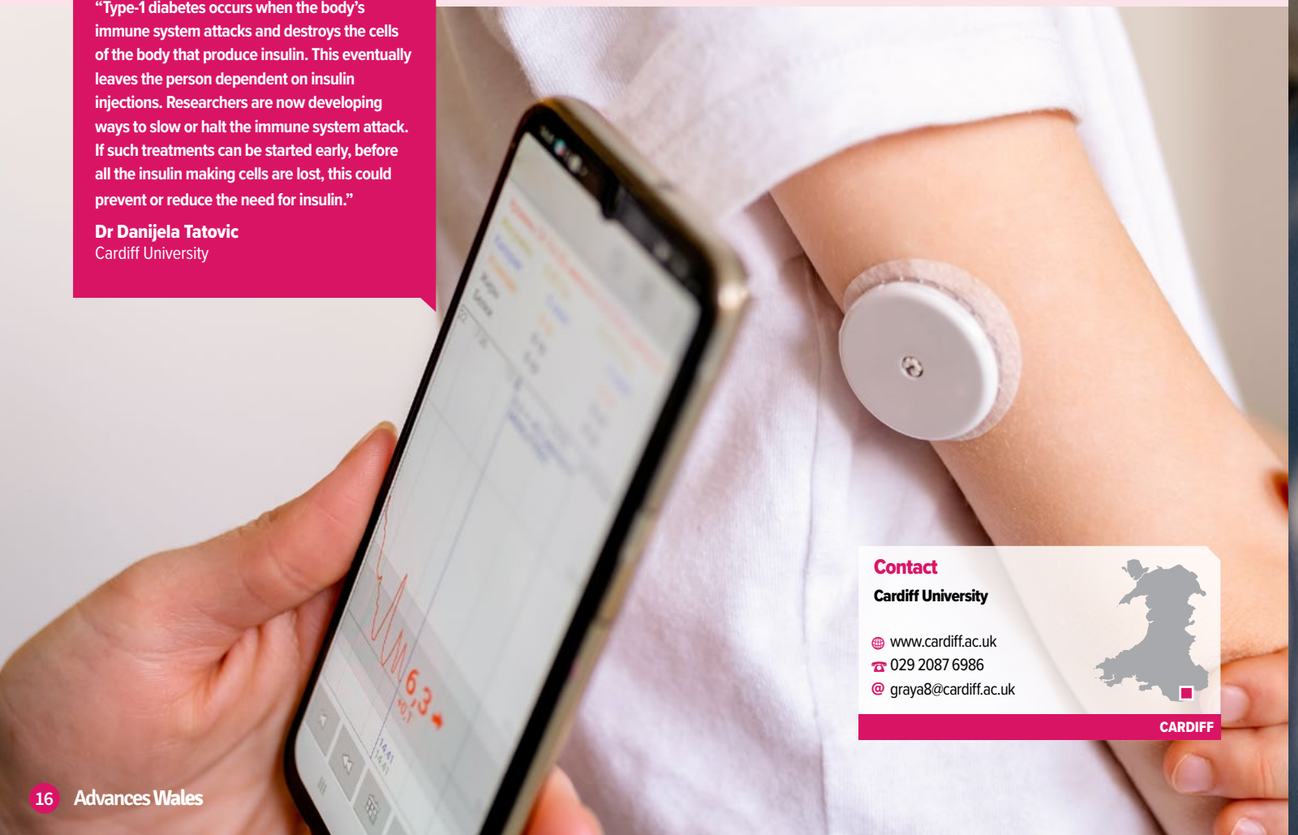
Conducted in collaboration with Swansea University, the study suggests that Ustekinumab, a medication used to manage psoriasis, can preserve the body's ability to produce insulin in patients recently diagnosed with type 1 diabetes. This breakthrough could transform diabetes management by reducing reliance on insulin.

Ustekinumab is an injection treatment which patient self-administers at home once every two months. It has been successfully used in over 100,000 patients with various immune conditions, including arthritis and inflammatory bowel disease, and is known for its minimal side effects. This trial marks the first time this medicine has been evaluated in a controlled setting for type 1 diabetes. The research showed that it decreases the levels of a group of immune cells known as Th17 cells. Despite being only 1 in 1,000 blood immune cells, Th17 cells are responsible for most of the problem in type 1 diabetes patients. This selective ability to target problematic cells explains Ustekinumab's low side-effect profile, highlighting its effectiveness as a form of precision medicine.

The study involved 72 adolescents aged 12 to 18 who were treated within 100 days of their type 1 diabetes diagnosis. After 12 months of treatment, the researchers observed that C-peptide levels – a measure of the body's insulin production – were 49% higher in participants receiving the drug compared to those receiving a placebo. The treatment demonstrated a strong safety profile, with no more adverse effects than those seen in the placebo group.

Currently, children at risk of developing type 1 diabetes can be identified years before insulin is required, using a simple finger-prick antibody test. Combining screening with early treatment using Ustekinumab can offer a promising approach to prevent the need for insulin. The researchers say that further trials will be necessary to confirm these findings.

> **"Type-1 diabetes occurs when the body's immune system attacks and destroys the cells of the body that produce insulin. This eventually leaves the person dependent on insulin injections. Researchers are now developing ways to slow or halt the immune system attack. If such treatments can be started early, before all the insulin making cells are lost, this could prevent or reduce the need for insulin."**
>
> **Dr Danijela Tatovic**
> Cardiff University



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CARDIFF

Clearing the air: cutting-edge filters tackle surgical smoke

A Cardiff-based company meets the challenge of surgical smoke during operating procedures.

Traditional methods of managing the smoke produced by modern surgical tools are criticised for being noisy, cumbersome, and disruptive during procedures. In response, Cardiff-based Alesi Surgical has developed a silent and efficient electrical filtration system to address these challenges in modern surgical settings.

This innovative system addresses the hazardous byproducts produced by electronic surgical tools, commonly referred to as surgical smoke or plume. These byproducts contain harmful chemicals, tissue fragments, and potentially infectious agents, such as viruses. Surgical smoke not only presents health risks to operating room staff but can also interfere with surgical procedures. Research indicates that particles in surgical smoke can be as small as 10 nanometers, which are too minute for standard surgical masks to filter. With growing awareness of these risks and the increasing introduction of legislation worldwide mandating smoke management, the demand for effective solutions is rising.

The company's new Ultravision2 surgical smoke control system and IonPencil diathermy pencil expands the use of their product range beyond an original focus on keyhole laparoscopic procedures to include open surgical procedures. As well as minimising smoke release into the operating room, and the related dangers this creates, the new technology also improves surgeon visibility. The diathermy pencil integrates with the surgical smoke control system and provides an effective smoke management solution for use in all conventional open procedures.

Independent studies have shown that the company's first-generation system is up to 23-times more effective at reducing smoke release during laparoscopic surgeries compared to traditional methods. It also reduces the spread of viruses in surgical smoke, addressing safety concerns for both patients and healthcare professionals.

This new advancement should further boost surgical safety and efficiency, providing an effective response to the increasing global concerns about surgical smoke.

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CARDIFF

Research shows bacteria trigger type-1 diabetes

New research suggests bacterial infections may trigger type-1 diabetes.

Scientists at Cardiff University have discovered that proteins produced by bacteria may activate the immune system to attack insulin-producing cells, potentially leading to the onset of type-1 diabetes.

The research highlights the role of killer T-cells in the development of type-1 diabetes. These specialised white blood cells are able to destroy foreign cells, cancer cells, and virus-infected cells, but the researchers have found that proteins from specific bacteria, known to infect humans, can stimulate these cells to mistakenly attack healthy insulin-producing cells. Normally tasked with protecting the body, they may instead target the body's own insulin-producing cells after exposure to these bacterial proteins.

In laboratory experiments, the team introduced bacterial proteins into cells derived from healthy donors and observed how killer T-cells responded. They found that strong interactions between the T-cells and the bacterial proteins caused them to attack the insulin-producing cells, which are crucial for regulating blood sugar levels.

This response was linked to a specific human leukocyte antigen (HLA), a gene that plays a key role in helping the immune system distinguish between the body's own cells and foreign invaders. This particular HLA variant, associated with bacterial infections that may trigger type-1 diabetes, is found in only about 3% of the UK population. As a result, the bacterial infections capable of generating these destructive anti-insulin cells are rare, affecting only a small portion of individuals.

Currently, there is no cure for type-1 diabetes, and patients must manage the condition through lifelong insulin treatment, which can lead to complications later in life. This study offers new insights into the underlying causes of the disease which could help in the development of more effective future treatments.

The research team hopes that a deeper understanding of this process will lead to new methods for diagnosing, preventing, or even halting the progression of type-1 diabetes, as well as improving treatment strategies before symptoms appear.

> **"Type-1 diabetes is an autoimmune disease that usually affects children and young adults, where the cells that produce insulin are attacked by the patient's own immune system. This leads to a lack of insulin, meaning that people living with type-1 diabetes need to inject insulin multiple times a day to control their blood sugar levels."**
>
> **Professor Andrew Sewell**
> Research Lead
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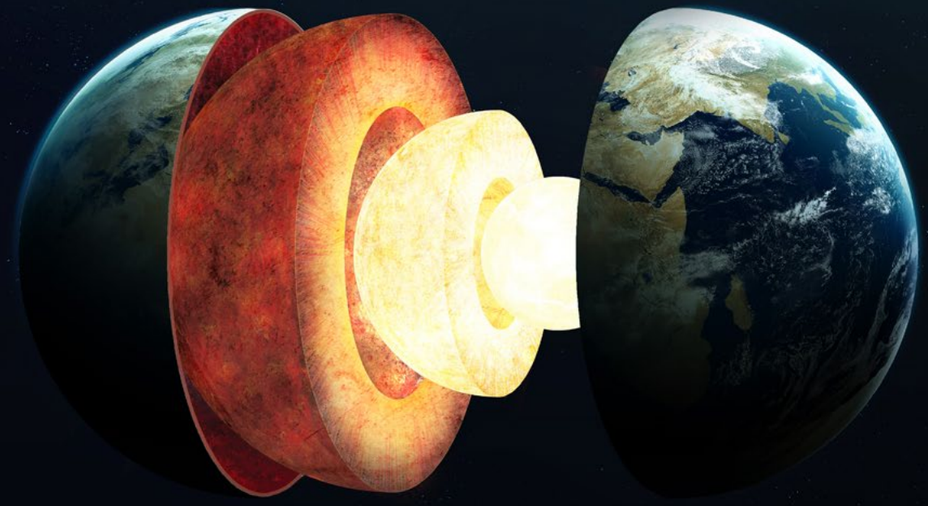
CARDIFF

Earth's mantle may hold clues to the origins of life



A research team, including scientists from Cardiff University, has recovered a section of rocks which originated in the Earth's mantle, the thick layer beneath the crust, which could provide valuable insights into the mantle's role in the origins of life on Earth.

These rocks may offer new perspectives on the planet's history, including the volcanic activity generated when the mantle is molten and how it drives global cycles of essential elements such as carbon and hydrogen. By analysing the rocks, scientists can deepen their understanding of how the Earth formed and evolved.

The samples were retrieved from a "tectonic window" - a region of the seabed where mantle rocks are exposed - along the Mid-Atlantic Ridge, during an expedition by the ocean drilling vessel JOIDES Resolution, in the spring of 2023. The expedition team successfully recovered an almost continuous 1,268-metre core, marking the first time such a large sample of the Earth's mantle has been extracted. The team is now analysing the composition, structure, and physical properties.

The findings reveal that the rocks contained lower levels of the mineral pyroxene and higher concentrations of magnesium than expected. This suggests that the mantle has undergone significant melting as it ascended from deeper layers towards the Earth's surface.
The researchers believe further analysis of this process could shed new light on how magma is formed, leading to volcanic activity. The researchers also discovered channels in the mantle where magma travels upwards towards the Earth's surface.
By studying these channels, they can trace the formation of magma deep in the mantle and its movement towards volcanoes.

This is important because it enhances our understanding of how the mantle melts and feeds volcanic activity, particularly on the ocean floor, where most of the Earth's volcanic activity occurs. With access to these mantle rocks, scientists can now connect volcanic eruptions to their deep origins, providing insight into the causes and processes behind these eruptions.

The study also provides early findings on how olivine – a common mineral in mantle rocks – interacts with seawater, triggering chemical reactions that produce hydrogen and other molecules capable of supporting life. The team believe that this process may have been a fundamental step in the origins of life on Earth.

> **"When we recovered the rocks last year, it was a major achievement in the history of Earth sciences. But beyond that, the real value lies in what the mantle cores can reveal about the composition and evolution of our planet. Our study is the first step in exploring the mantle's composition by documenting the mineralogy and chemical makeup of these rocks. Our results were unexpected. There is far less pyroxene and significantly higher levels of magnesium than predicted, showing that the mantle has experienced much more melting than previously thought."**
>
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CARDIFF

Mapping biodiversity through airborne DNA

Researchers at Bangor University, in collaboration with the University of Jyväskylä in Finland, have revealed a new method for detecting previously unidentified global fungi species by analysing air samples.

Despite the incredible diversity of life on Earth, scientists have only scratched the surface when it comes to naming and identifying species, especially in the realms of insects and fungi – among the most diverse groups of organisms. Many millions of these species are still waiting to be discovered.

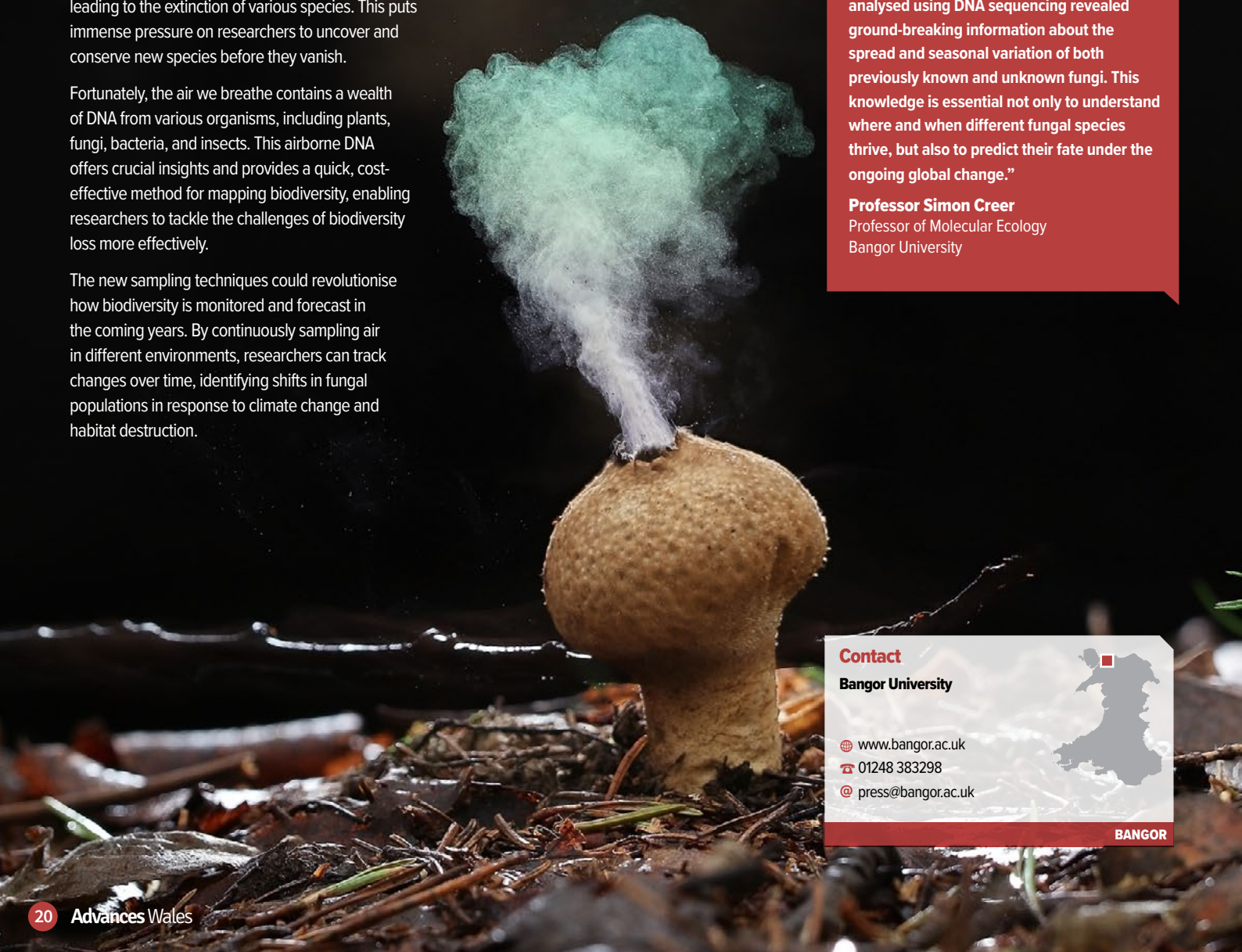
At the same time, habitats are being lost at alarming rates, with severe consequences for biodiversity – threatening ecosystems, disrupting food chains, and leading to the extinction of various species. This puts immense pressure on researchers to uncover and conserve new species before they vanish.

Fortunately, the air we breathe contains a wealth of DNA from various organisms, including plants, fungi, bacteria, and insects. This airborne DNA offers crucial insights and provides a quick, cost-effective method for mapping biodiversity, enabling researchers to tackle the challenges of biodiversity loss more effectively.

The new sampling techniques could revolutionise how biodiversity is monitored and forecast in the coming years. By continuously sampling air in different environments, researchers can track changes over time, identifying shifts in fungal populations in response to climate change and habitat destruction.

One particularly exciting area for future research involves analysing the sequences of fungi that are important to humans, such as those responsible for diseases in humans, crops, and livestock. Additionally, certain fungi can serve as indicators of environmental health, helping to monitor the decline of natural ecosystems.

By understanding these relationships, scientists can better assess the impact of biodiversity loss and develop strategies for conservation. This innovative approach to studying air samples could ultimately lead to a deeper understanding of the vital connections between different species and their environments, paving the way for more effective conservation efforts.



"Air samples collected around the world and analysed using DNA sequencing revealed ground-breaking information about the spread and seasonal variation of both previously known and unknown fungi. This knowledge is essential not only to understand where and when different fungal species thrive, but also to predict their fate under the ongoing global change."

Professor Simon Creer
Professor of Molecular Ecology
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BANGOR