

British Geochemist Deciphers Earth's Secrets

Dialogue

By LONG Yun & BI Weizi

When British isotope geochemist Robert Mark Ellam first encountered geology in high school, he never imagined it would lead to a lifetime of unraveling Earth's deepest mysteries, or even land him a place on the examination panel for a Ph.D. thesis on Vermeer's "Girl With a Pearl Earring."

Recently, he sat down with *Science and Technology Daily* to discuss his scientific journey and the unexpected intersections of his career.

Academic foundations and early discoveries

Now a fellow of the Royal Society of Edinburgh and a chair Professor at Tianjin University, Ellam traces the beginning of his path into geochemistry to a stroke of luck. Back in the day, his high school offered geology as a subject, which was rare for the time. "Geology was both interesting and relatively easy to understand," he recalls, contrasting it with the abstract challenges of chemistry and mathematics. With good grades in Geology and Physics, he secured a place at Imperial College, London, becoming the first in his family to attend university.

Ellam was initially drawn to the petroleum industry due to the booming oil prices and plentiful job opportunities. However, his perspective shifted dramatically during his university years. "University geology was a revelation," he shared, noting the revolutionary discoveries in the field, particularly the concept of plate tectonics. His fascination with deep Earth and volcanic rock formation in subduction zones led him away from petroleum and towards pure research.

His Ph.D. work at the Open University focused on subduction-related volcanoes in Italy, where he integrated new



Professor Robert Mark Ellam (first from the right). (COURTESY PHOTO)

techniques to measure trace elements and isotopes. "My paper with Chris Hawkesworth was probably about 85 percent correct," he said, acknowledging that subsequent studies have refined his original model, which has remained largely intact for nearly 40 years.

Contributions to the sci-tech community

Throughout his illustrious career, Ellam has divided his research into two main categories: mantle geochemistry and igneous petrogenesis, alongside exploring the applications of isotopes in Earth and Environmental Science. His work on the North Atlantic large igneous province has been particularly influential. "In the early 2000s, we discovered the highest magmatic $^3\text{He}/^4\text{He}$ values from terrestrial basalts from Baffin Island and West Greenland," he explained. This discovery hinted at the existence of ancient geochemical reservoirs deep within the Earth.

Ellam has also been eager to apply isotope geochemistry beyond traditional boundaries. "I have always been enthusiastic to apply isotope geochemistry out-

side my intellectual 'comfort zone,'" he said, highlighting his collaborations that span diverse fields, from reconstructing ocean circulation to tracing sources of heavy metal pollution.

Bridging research and real-life applications

In terms of the real-life applications of his research, Ellam highlighted the importance of curiosity-driven science. "I want to understand the details of how the Earth works in a way that goes beyond what many might consider necessary," he said. He noted that the advancements in geochemistry have had profound implications for understanding natural hazards, climate change, and even forensic science.

One notable achievement was a paper published in 2001 in *Science* magazine, where Ellam co-authored a study demonstrating that El Niño phenomenon has been a robust component of climate for at least 120,000 years. "We were able to show that this wasn't just a modern phenomenon. It has been a key player in Earth's climate system for millennia," he pointed out.

Another significant achievement occurred during his tenure as director of research at the Scottish Universities Environmental Research Centre, where radiocarbon scientists successfully identified the skeleton of King Richard III, discovered beneath a parking lot in Leicester. "Initial radiocarbon dating appeared inconsistent, but stable isotope analysis revealed a significant marine reservoir effect that brought the age into agreement with historical records," he said.

The role of scientists in society

As the epigraph of his Ph.D. thesis, Ellam used a quotation attributed to the Victorian biologist and anthropologist, and fellow Imperial College alumnus, T. H. Huxley — "The great tragedy of science: the slaying of a beautiful hypothesis by an ugly fact."

His reflections on the role of scientists in society are both profound and thought-provoking. He emphasized that the ability to change one's mind in the face of new evidence is a hallmark of scientific progress. "The beauty of a life in science has been the state of always being uncertain about your most important current preoccupation," he said.

However, he also acknowledged the social expectation for scientists to provide certainty. "If 99.9999 percent of scientists consider there to be a climate crisis, we should not let our enthusiasm for uncertainty allow the dissenting voice to dominate the political agenda," he cautioned.

Ellam's commitment to international collaboration is evident throughout his career. He has co-authored publications with researchers from over 25 countries, emphasizing that science transcends nationality. "My passport tells me I am British and my work permit makes me part-Chinese for the next few years," he said, adding that being part of a global community is more important to his personal identity.

TJU also contributed to this article.

Overseas Echoes

Stretching Boundaries of Europe's Robot R&D

By LI Shan & BI Weizi

At the 2025 European Robotics Forum in Stuttgart this March, Dr. Sebastian Reitelhofer, head of robotics research at Germany's Friedrich-Alexander University of Erlangen-Nuremberg (FAU), told *Science and Technology Daily* that Europe had accumulated technical and personnel advantages in the field of complex integrated systems, which can combine digital, analog, optical and micro-mechanical functions in a single system. The key, according to Reitelhofer, is to create a good match between products and markets, bringing laboratory research results to the market and then scaling them up.

Robotics research should closely follow industrial needs

In the exhibition area of the forum, Reitelhofer showed *Science and Technology Daily* the cable-operated parallel robot his team has developed. "This is a simple model to demonstrate the results of our research. [Through] a combination of passive and active cables, like the movement of a human hand, the position can be adjusted by three active cables driven by motors. The advantage of these structures is that they can isolate more than 80 percent of the impact force. This means that if a robot with this structure hammers a nail into the wall, its transmission servo will not be damaged," said Reitelhofer.

This hybrid kinematics, consisting of traditional kinematics and tensegrity kinematics, is used to build fast and robust robots. "These cables and actuators are like human muscles," said Reitelhofer. "Each degree of freedom requires a corresponding actuator. For example, a shoulder joint requires four actuators. If more actions are required, such as an entire arm, more 'muscles' have to be added."

Reitelhofer's approach to robotics research is to closely follow the needs of industrial applications. Recently, he combined deep reinforcement learning and imitation learning to propose and verify a hybrid operation learning method, that can reduce the robot's adaptation time to new components and changing scenarios, such as industrial box picking. He has also developed a visual servo system, consisting of a six-axis industrial robot and a high-precision multi-

camera tracking system, that can achieve extremely high positioning accuracy on demand.

Europe's advantage lies in complex systems research

Speaking about Europe's robotics research, Reitelhofer said, "Europe's advantage lies in its ability to carry out very complex systems research. For example, the life-support system in the NASA-led Artemis lunar landing program, the most complex module that was developed by European scientists. Whenever it comes to building complex systems, integrating different fields and ensuring high quality and reliability, Europe's advantages can be reflected."

"I hope that we will continue to see excellent European robotics products in the future. Although we may still have to work with some manufacturers who provide cheap hardware, we can combine artificial intelligence and hardware to create complex systems. I think we already have a certain advantage in this respect. By combining the whole process with data protection, these systems can be accepted by the market," he added.

Humanoid robots herald technological revolution

Commenting on the development of robots in Asia, Reitelhofer said in some parts of Asia, people are now catching up. "Many excellent products are being produced in China. However, some products still need continuous improvement. For example, the robot's footfalls are too heavy when walking, and the overall innovation culture needs to be developed," he added.

When asked about the Beijing Half Marathon in April, where more than 20 humanoid robots will compete, Reitelhofer was upbeat but cautious. "This demonstrates the current enthusiasm for humanoid robots. Today's robot technology is undergoing a revolution. There are many possible applications in manufacturing. But these robots have a lot of work to do before they can coexist with us. Safety comes first. The robot must not damage furniture or endanger people. Secondly, building a great humanoid robot also requires new technologies, such as soft interfaces, artificial muscles, better vision and hearing systems and, of course, constantly improving artificial intelligence."

Traditional Eastern Wisdom

Master Art of Light and Shadow

By BI Weizi

Chinese shadow puppetry is a form of theater of colorful silhouette figures made of leather or paper, and accompanied by music and singing. Manipulated by puppeteers using rods to which the figures are tied by strings, the figures create the illusion of moving images on a translucent cloth screen illuminated from behind.

The earliest written record about the origin of shadow puppetry can be traced back to the Western Han Dynasty (206 BC — 24 AD), as documented in *Hanshu* (The Book of Han). From then on, shadow puppetry gradually gained popularity and spread to West Asia and Europe through trade during the Yuan Dynasty (1271 AD — 1368 AD).

The shadow puppets used in China are typically semi-transparent leather plates to which semi-transparent dyes are applied. As a result, the shadows cast onto the screen during the performance tend to be colorful.

The dyed leather is cut into the shape of humans, birds and beasts, and background objects. The leather carving has to be an arduous balance of three elements: a sharp blade, supple leather and a masterful hand. These three elements are the key requisites for making a beautiful shadow puppet.

The most intricate carving methods use a push-knife on slightly moistened leather to get the best control. Since the process of perfectly moistening the leather can take up half the preparation time, many of the "newer"

methods (400-600 years old) did away with that by using thinner leather and a pull-knife or sawing knife. The translucent puppets come to life when exposed to light.

Over centuries, the design and aesthetics of Chinese shadow puppetry have developed into one of the world's most complex art of light and shadow. In 2011, UNESCO listed

Chinese shadow puppetry as an intangible cultural heritage of humanity.



A Chinese shadow puppetry artist performs in Xiaogan city, Hubei province. (PHOTO: VCG)

LLM Speeds Up High-altitude Research

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Dubbed the "Water Tower of Asia," the plateau is one of the most sensitive regions to climate change in the world. The second scientific expedition and research project on the Qinghai-Xizang Plateau found that the solid water on the plateau is rapidly melting and liquid water is increasing. The uncertainty caused by climate change could result in potential water and energy conservation risks on the plateau.

In the face of this challenge, CAS's Institute of Tibetan Plateau Research (ITP), in cooperation with Aliyun or Alib-

aba Cloud, has created "Luoshu," the first water-energy-food multi-modal reasoning LLM focusing on climate change adaptation.

Studying water-energy-food coupling — the complex interdependence and influence relationships between water resources, energy systems and food production — is crucial to developing more resilient coping strategies.

Xia Zuihui, an assistant researcher at ITP, said Luoshu is based on ITP's self-developed model "Siyuan," and trained on the spatial and temporal data of the plateau. Its output consists of two parts:

the runoff volume that directly supports hydropower production forecasts, and the high-dimensional data that accurately depicts hydrological processes.

However, humans cannot directly understand and use these data. After Siyuan is connected to Qwen, it can realize natural language query and output, and realize the visual presentation of high-dimensional data, based on which frontline personnel can make decisions directly, Xia said.

What's more, in combination with Siyuan and QwQ-32B, Luoshu can directly analyze the data to draw conclusions. For example, questions such as what to observe during the dry season and what to do in the future to adapt to climate change can be explained through LLM

reasoning, thus aiding decision-making, Xia explained.

In this research, the team also handles massive data and complex computing tasks for rapid experimentation and iteration of the model with the help of the AI computing resources, data storage and deep learning platform provided by Aliyun, significantly enhancing the efficiency of scientific research.

In the future, Luoshu will also be connected to Qwen-VL to efficiently identify image data, and synergize with the intelligent body, embodied AI observation, and air and sky integrated dynamic data center. This will provide sci-tech support for ecological protection and sustainable development of the Qinghai-Xizang Plateau.

IODP Gives Marine Research More Muscle

Science Outreach

By Staff Reporters

The International Ocean Discovery Program (IODP) concluded in 2024, after 11 successful years of study. The international marine research collaboration explored the history and dynamics of Earth, using ocean-going research platforms to retrieve data recorded in seafloor sediments and rocks, and monitor the subsurface environment. Since its inception in 1968, IODP has played a major role in advancing human understanding of climate and ocean change and Earth's history and dynamics.

China joined IODP in 1998 and carried out the first deep-sea scientific drilling in Chinese waters in 1999, achieving many innovative results, including the long cycle of climate evolution. Since then, it has conducted three drillings in the South China Sea under the Matching Proposal Project, opening up a new research perspective on the

evolution mechanism of marginal seas.

With the completion of the trial voyage of China's first domestically built drilling ship *Mengxiang* in December 2023, China officially became the third country in the world to have its own professional ocean drilling ship, also known as the aircraft carrier of marine science.

With a world-leading marine drilling capacity, the ship will drill through Earth's crust and into the upper mantle, contributing to the study of Earth's history and dynamics. The mantle, which accounts for four-fifths of Earth's volume and three-quarters of its mass, is full of scientific mysteries waiting to be explored by scientists.

According to Tuo Shouting, director of the IODP-China Office, China has already established an IODP-China Executive Science (2025-2035), and the completion of *Mengxiang* will provide key equipment support for future China-led expeditions.

China-initiated ocean drilling will greatly enhance the country's innovation capabilities in deep-sea scientific research and observation and intelligent equipment development.