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MEDIA RELEASE

UP scientists lead Mpumalanga study of natural hydrogen gas discovered under Earth's surface

Scientists at the University of Pretoria (UP) are leading a study of natural hydrogen gas discovered under the Earth's surface in Mpumalanga – a source of renewable energy that could contribute to the national energy budget and help address the energy shortage in South Africa.

While it is still too early to know how much of an effect the discovery could have on the country's national energy landscape if exploited, the scientists have envisaged small "stand-alone" generation units (powering generators with a capacity of about 20 kilowatts) for local domestic or minor industrial use. However, recent stories in Europe suggest that some natural hydrogen resources might be much bigger than originally thought.

"There might well be an untapped renewable, non-polluting energy supply that has gone unnoticed for centuries, right under our noses!" said structural geologist Professor Adam Bumby. "Only in the past few years have geoscientists started to measure natural hydrogen flux out of the Earth, and we have already demonstrated that this is the case in parts of Mpumalanga. Our local scientists, with their geological and geophysical knowledge of the potential source rocks, combined with the expertise of our European partners, are proving to be a successful team."

Prof Bumby added that they are in the process of identifying potential source sites, after which they will be able to quantify estimated resources.

"The role of this project is to indicate the presence of hydrogen, and how it could be incorporated into the national energy budget if it were to be exploited."

This discovery was made as part of the HyAfrica project undertaken by a consortium of partners within the European Union (EU) and African Union (AU).

Recent samples taken in Mpumalanga currently fall under the natural/"white" hydrogen category. Follow-up field trips and isotopic comparisons of all the hydrogen samples collected will provide a clearer understanding of the geological controls responsible for generating hydrogen in Mpumalanga. According to Prof Bumby, it is difficult to estimate at this point how long it will take to properly exploit any decent reserves of hydrogen.

He added that hydrogen is considered a fuel of the future due to it emitting zero emissions.

“It can be used, for instance, in car engines instead of petrol, producing water as the exhaust gas. Hydrogen is the most common element in the solar system, but sadly most of it is either sitting or burning in the sun. Hydrogen can also be synthesised from water using electrolysis, but it requires a lot of energy to split water.”

The energy to produce hydrogen fuel by electrolysis of water can be sourced from renewables (such as solar energy or wind turbines) and is called “green” hydrogen. Alternatively, the energy needed for the split can be sourced by burning fossil fuels (“grey” hydrogen), but that produces carbon dioxide, which is a greenhouse gas. If that greenhouse gas is captured and stored (sequestered), it’s called “blue” hydrogen.

Natural hydrogen (or “white” hydrogen) is different because the energy needed to break the hydrogen from water is provided by geological processes through chemical reactions in rocks driven by high temperatures at depth in the Earth’s crust (serpentinisation). The decay of radioactive elements in some minerals deep within the Earth’s crust can also result in hydrogen being split off from water (radiolysis).

“Because these reactions and processes are occurring relentlessly in some geological environments, the hydrogen that is produced by these natural processes can be considered renewable,” Prof Bumby explains. “Because hydrogen is a very light element, it readily rises towards the Earth’s surface, where it either gets trapped under impermeable rock layers or leaks up to the surface. It is these leaks of natural hydrogen that we are trying to trace in Mpumalanga for this part of the HyAfrica project.”

Prof Bumby added that environmentalists and climate change activists will also be interested in the potential impact of the development of natural hydrogen as a commodity in South Africa.

“In other areas where hydrogen has been exploited in the past, the extraction of natural hydrogen typically requires drilling a borehole, and a motor engine adapted to run on hydrogen,” he said. “No further invasive procedures are envisioned. Burning hydrogen in engines does not produce any carbon dioxide – or any other greenhouse gas – that contributes to global warming. The only combustion product is water. If the hydrogen is not exploited, it seeps from the Earth into the atmosphere, reacts with oxygen and still forms water.”

The project was tasked with looking for sources of natural hydrogen in Africa, and exploring the possibility of using natural hydrogen for stand-alone renewable energy solutions. The partners fall under the umbrella of LEAP-RE (Long-term Joint EU-AU Research and Innovation Partnership on Renewable Energy). The AU partners are in Morocco, Togo, South Africa and Mozambique.

The South African scientific partners in the HyAfrica consortium are Prof Bumby and Dr Ansie Smit of UP’s Department of Geology, Prof David Walwyn of the UP Graduate School of Technology Management (GSTM), along with Samson Masango and Prof Napoleon Hammond of the University of Limpopo. Other consortium partners are the Université Mohammed Premier, Oujda (Morocco); University of Lomé (Togo); Eduardo Mondlane University (Mozambique); Converge!/University of Évora (Portugal); the Leibniz Institute for Applied Geophysics (Germany); and the Fraunhofer Institute (Germany).

“There remains a great deal of work ahead for the team to consider necessary regulation and legislation associated with exploitation of these resources,” Prof Bumby said. “The later working groups of the HyAfrica project will consider those economic and political aspects.”

GSTM’s Prof Walwyn, who has expertise in the challenges of industrial development in South Africa and the development of green hydrogen as a potential energy source, forms part of this working group. The groups kicked off their work during the second LEAP-RE HyAfrica General Assembly held at UP recently.

Captions:

1: MSc students from the University of Pretoria and University of Limpopo drill a shallow hole (1m deep) into the soil on the edge of a pan in Mpumalanga. The emission of natural hydrogen through this hole into the atmosphere is recorded by a hydrogen meter.

2: Students make use of a pit dug for the installation of electricity poles, to measure the concentrations of hydrogen at different depths in the exposed soil.

3: Measurement of hydrogen concentrations in a freshly-drilled hole. Measurements of over 10000 ppm have been recorded by the team in parts of Mpumalanga

4: Members of the HyAfrica consortium assemble at the Future Africa campus for the 2023 General Assembly

5: Local and international members of the HyAfrica team met with South Africa stakeholders ranging from government to the mining industry.

Infographic:

Hydrogen is considered a fuel of the future due to it emitting zero emissions. This infographic explains the impact of this discovery as well as some interesting facts about hydrogen and the different forms of it. Samples from Mpumalanga currently fall under the natural/"white" hydrogen category. Further studies will provide a clearer understanding of the geological controls responsible for generating hydrogen in Mpumalanga.

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ABOUT THE UNIVERSITY OF PRETORIA

The University of Pretoria (UP) is one of the largest contact and residential universities in South Africa, with its administration offices located on its Hatfield Campus in Pretoria. This 115-year-old institution is also one of the largest producers of research in South Africa.

Spread over seven campuses, it has nine faculties and a business school, the Gordon Institute of Business Science (GIBS). It is the only university in the country with a Faculty of Veterinary Science, which is ranked the best in Africa.

UP has 120 academic departments and 92 centres and institutes, accommodating more than 56 000 students and offering about 1 100 study programmes. It has the most academic staff with PhDs (70%), NRF-rated researchers (613).

The 2023 QS World University Rankings by Subject ranked UP first in South Africa in Accounting and Finance, Law, Economics and Econometrics, Mechanical Engineering, Electrical and Electronic Engineering, Chemical Engineering, Mathematics, and Veterinary Science.

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