Let's get geophysical

U of T geology undergrads prospect for archaeological remains at Tell Ta'yinat, Turkey

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VARSITY CONTRIBUTOR

Since the early 1920s, researchers and adventurers alike have been attracted to the dense archaeological treasures of the Amuq plain in southeastern Turkey. Some of the first expeditions were led by Robert Braidwood from the University of Chicago, whose excavations revealed mosaics, sculptures, pillars, and clay tablets with cuneiform inscriptions. However, due to shifting political tides, operations at the site were abandoned, leaving it to become overgrown, and eventually bulldozed to develop local cotton farms. Although the work done was never published, in 2003 the University of Toronto founded the Ta'yinat Archeology Project (TAP), reigniting interest in the long forgotten site.

A team of six geology students were invited this summer by the TAP to conduct various geophysical surveys under the supervision of Dr. Charly Bank, a senior lecturer at the Department of Geology. The students performed three weeks of fieldwork at Tell Ta'yinat, with data analysis and interpretation continuing into the current academic year.

The TAP team includes professionals in a wide range of specialties including paleoethnobotany, zoology, epigraphy, photography, illustration, and conservation. They have one common goal: to piece together the puzzle behind the origin of this ancient buried city and the people who lived there.

The site, encompassing around 20 hectares of land, was once the ancient capital of the "Land of Palastin." For decades, archaeologists were puzzled by the site's proximity to other known Bronze Age sites as well as several gaps in the archaeological record. However, a recent unearthing of a 2700 year-old tablet at Ta'yinat has revealed that the occupation of the site may have been cut short by acts of pillage and mass burning.

The task at hand for the students was to investigate targets of archaeological interest that were out of reach for basic field techniques. The crew would drive to the excavation site before dawn to conduct the surveys while temperatures were cooler. At noon, they would pack up the equipment and return home to study the new data. Environmental geosciences and physics student Kanita Khaled points out, "It was incredibly hot and dry up on the mound, especially with the heavy equipment that we had to carry around with us for the seven-hour surveys."

Good communication in the field is essential to geologists. The seven-member team was divided into at least three groups, with each group venturing out into different areas of Tell Ta'yinat to perform geophysical surveys. PIERRE GRONDIN LEBLANC

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Scientists use the geophysical methods of magnetometry and resistivity to map the subsurface of regions of archaeological interest. These methods rely on the principle that different materials have different physical characteristics. Just as one can identify a mud brick wall from surrounding dirt by its texture, one can also use more complex physical characteristics such as density, electrical conductivity, viscosity, magnetic field, and capacitance to distinguish subsurface materials.

Magnetometry is a technique in which subsurface materials are distinguished based on their influence on the earth's magnetic field. One way to collect data over a large area is to attach a GPS antenna onto a magnetometer and traverse the area in a grid pattern. A slower, but more precise method is to manually collect data points at measured intervals. Thousands of individual readings are needed to make a single magnetic map.

Ironically, the mysterious fire that had baked the city's walls provided a slight advantage to the geologists. Since burnt mud-brick is more magnetic than its surroundings, it features more prominently in the magnetic maps.

The researchers found that a key area of interest lay on the lower mound, an area now covered by cotton fields, under which lay the remnants of the city wall. Although a visible topographic change indicated the approximate location of the wall, magnetometery data proved a compositional boundary as well.

Another team of researchers set out to collect data with another technique known as resistivity. Resistivity is the method by which an electrical current is passed into the ground by a pair of electrodes while the resistance of the subsurface is measured by another set of electrodes. Because the physical properties of the layers and objects in the subsurface are different, they can be mapped out based on their resistance.

Various resistivity results produced at Tell Ta'yinat displayed blocky, almost rectangular, anomalies of high resistance, which could be attributed to possible building walls.

The students involved hope the results produced will prove themselves valuable and lead future archaeological work to new discoveries. "Working on the field and in the laboratory allowed our team to acquire important professional experience and skills as well as to provide data for the Ta'yinat Archaeological Project," notes geology student Pierre LeBlanc.

This work was possible through the Faculty of Arts and Science's Independent Experiential Study Program. According to Bank, the research team's supervisor, "Such a project allows student the rare opportunity to work on an interdisciplinary project and view their contribution as piece of a larger puzzle put together by researchers in history, artefact preservation, textile production, zooarchaeology, and social network analysis."

Tech review: Bloom Box

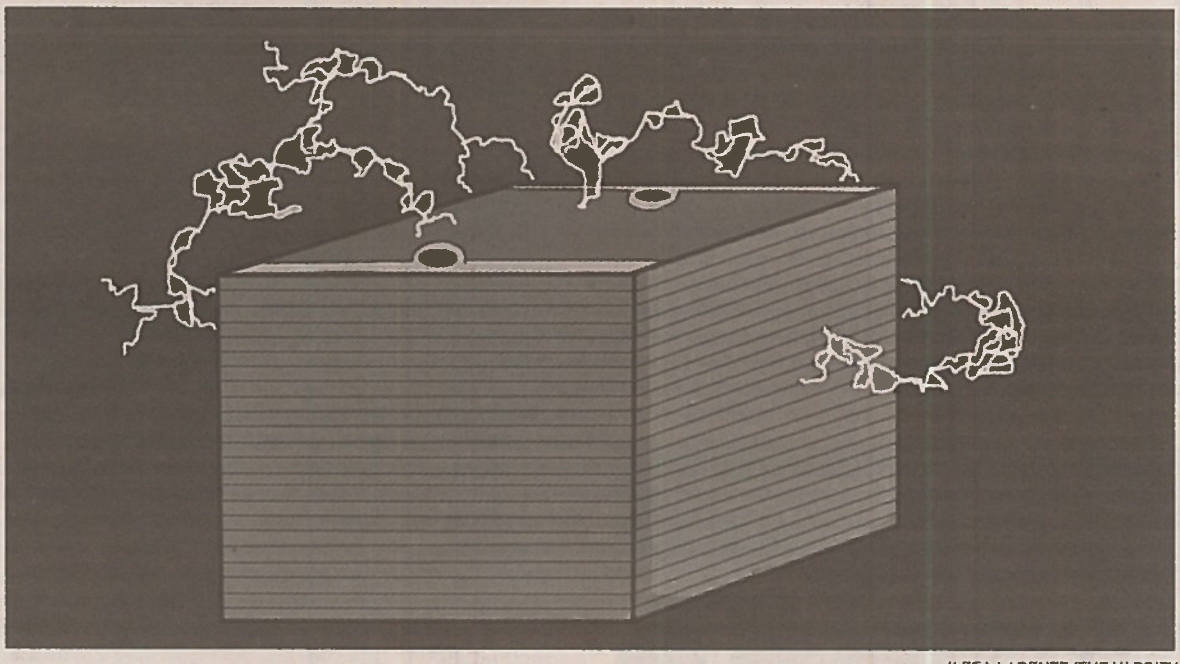
Affordable sustainable energy for the win

Charlotte Tombs
ASSOCIATE SCIENCE EDITOR

The Bloom Box is a green tech innovation that has the ability to drastically change our way of life. Developed by Bloom Energy, a company that is working to change the way we produce and consume energy, the Bloom Box is meant to be a power source that is inexpensive and clean. The idea for the Bloom Box was derived from a project that Dr. Sridhar, from the University of Arizona, was asked to complete for NASA. This project involved creating a device that could sustain life on Mars by producing air and fuel from electricity, and vice versa.

When the Mars project ended in 2001, Sridhar and his team of engineers decided to apply the principles they used in the Mars device to an energy-producing box that could be used on Earth. The box is composed of "cells" made primarily of beach sand, which is baked and then cut into wafer-thin squares. The squares are painted onto one side with green ink and on the other side with black ink. Both inks were developed by Sridhar, and contain secret ingredients.

The cells are then assembled into boxes, with sheets of inexpensive metal alloy placed between each cell in the box. Oxygen is fed into the cell on one side, while fuel is fed into the cell on the other, creating a chemical reaction that produces energy. As Sridhar states, "Fuel goes in, air goes in, out comes energy."



ILEEA LARENTE/THE VARSITY

One box can power one European home, while two boxes are required to power one American home or four to six Asian homes.

John Doerr of Kleiner Perkins Caufield & Byers was the first to see potential in the company in 2002, and has been investing in it ever since. The Bloom Box is currently being tested at the data centres of many companies across the United States, including FedEx, Google, Ebay, Staples, and Walmart. These data centres require a few huge cylinders, each containing many Bloom Boxes, in order to power the centre. One cylinder costs between $700,000 and $800,000, and four are required to power the Google data centre.

However, the box has yet to operate flawlessly. For example, after only three weeks at the Google data centre, one cylinder suddenly stopped working.

This shows a huge concern among skeptics: the question of whether or not fuel cells can actually be used as sustainable energy. Michael Kanellos, Editor-In-Chief of the website GreenTech Media mentioned, "I'm hopeful but I'm skeptical: people have tried fuel cells since the 1830s and they're [a] great idea because they produce energy at an instant. [But the concern is] longevity."

Sridhar's goal is for Bloom Box to be powering homes all around the world in 10 years. He also expects that the unit required to power a home will cost less than $3,000. However, Kanellos argues that there is only a 20 per cent chance that this will occur — and if it does, the box will be a product of General Electric (GE) or another energy conglomerate, not Bloom Energy.

John Doerr invested $400 million up front into the Bloom Box back in 2002, which Kanellos says makes him cringe. "Anytime a company is given more than $100 million dollars up front, [one tends] to question the company and the investment." Doerr has some huge failures on his record, including the Segway. However, he has also had some huge successes, such as Amazon, Google, and Netscape.

The Bloom Box is already proving to be a valuable energy source for large companies — it saved Ebay $200,000 of energy costs in one year. Bloom Energy is also constantly receiving new orders from companies who are interested in trying out the Bloom Box.

However, a few questions remained unanswered: will the Bloom Box have a place in the home, and will it be possible to create an affordable box that can create sustainable energy? When told that his goals for the future seemed far-fetched, Sridhar replied: "My job is to see the world as it could be, not as it is right now."