



# Pacific International Space Center for Exploration Systems NEWSLETTER



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## APPLIED RESEARCH



### *Basalt Sintering for ISRU: Challenges in Creating a Unique Building Material*

*PISCES Geology & Materials Science technicians Kyla Edison and Kye Harford (shown above) have been researching various basalt sintering methods for novel uses on Earth and other planets. Their current focus is tile production using basalt of varying grain sizes to produce an extremely durable product resembling marble countertop.*

*By: Kye Harford*

As much as we want to expand and try different things with our sintering technology, we have been facing a problem where the basalt crystallizes to the surface of its casting mold. When this happens, it becomes nearly impossible to scrape or chip away the sintered fines without destroying the mold—and the product.

To solve this challenge, we first tried a different material for the mold that we hoped would not create adhesion with the sintered basalt. We conducted two trial bakes using plates made of vitreous alumina. One plate was polished using a wet polisher with 3000 grit, the other was left in its

original condition. One sample each of crushed and sieved basalt were placed in the middle of these plates and baked. Unfortunately, the results were unsuccessful and the crystallization between the basalt and mold actually strengthened. Next, we looked at an alternative mold release agent to prevent surface crystallization: yttrium oxide aerosol. We tested this rare, earth metal oxide agent in a high-temperature bake, but once again found the results to be unsuccessful.

With two failed attempts, Kyla decided we should instead alter the physical properties of the mold rather than its chemical composition.

*(Continued on pg. 3)*

### *Message from the Program Director*



Aloha Kakou,

April was an incredibly exciting month for the Aerospace Industry. I had the opportunity to attend the 35th Space Symposium in Colorado Springs and support the Hawaii Aerospace booth together with members from the Maui Economic Development Board, Hawaii Island Economic Development Board and the Office of Aerospace Development. The sheer number of attendees and exhibits at the event was eye opening, and shows the exponential growth and activity happening in this industry. This year's outdoor exhibit consisted of a full-scale model of Lockheed Martin's lunar gateway module (shown on next page). Attendees included representatives from domestic and international companies and agencies, small and large vehicle launch carriers, small satellite developers, laser-based communications and space tourism.

*(Continued on pg. 3)*

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# GUEST SPOTLIGHT

## Finding Pōwehi

By: Jessica T. Dempsey, PhD  
Deputy Director, EA Observatory/JCMT

*On April 10, 2019, the first image ever of a black hole known as “M87” was released to the world. Prior to this undertaking, blackholes had only been theorized and inferred through complex mathematical calculations. Now, there is undeniable, visible proof that they exist. Dr. Jessica Dempsey, deputy director of JCMT—one of two telescopes in Hawaii that contributed to the accomplishment—describes the incredible work that went into this groundbreaking image, and how it came to be named after an awe-inspiring concept echoed throughout the Hawaiian myth and creation chant, the Kumulipo.*

Black holes are a tantalizing idea, often imagined as great monsters of the universe devouring everything around them. They're also nearly always the first thing people will ask about when they find out you are an astronomer. They're a hard concept to get your head around. Vast, dense and dark objects that we know should exist, mathematically, and we've had many scientific results that infer their presence. But to image one? Instinct tells us this should be impossible. What is most amazing is imaging one is nearly technically impossible too. The first marvel of this breakthrough was the key to successfully capturing light from the great beast of a black hole: teamwork.

One telescope wasn't going to cut it. Neither was two, or three. In fact, it took the combined collecting power of nearly every telescope across the planet that could gather this type of light (millimeter-wavelength radiation) to achieve this. It took hundreds of technicians, engineers, telescope operators, scientists, theorists, software experts, plus a full two years of work after the April 2017 observing run to create this image.



*Above: At JCMT on Maunakea, Dempsey stands next to the EHT receiver, an instrument that helped capture and create the first image of a black hole. Courtesy photo: EAO/JCMT.*

Hawaii's two submillimeter telescopes, JCMT and SMA, pioneered the technology for this work more than a decade ago. They were also the western anchor that allowed the image to have the clarity it did. And what a marvel it is—this beautiful ring of light, precisely the way that Einstein predicted. (When I saw the image for the first time, I thought it was a model because it was too perfect!)

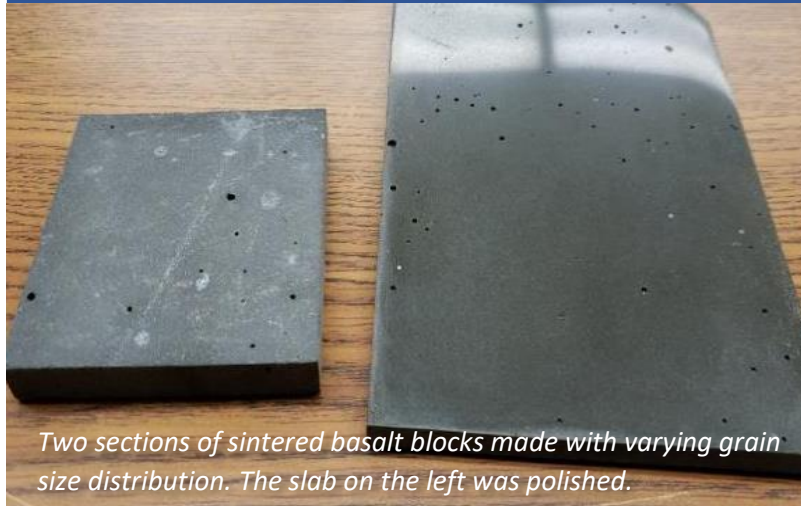
Following this incredible accomplishment, we had the great fortune to sit with Dr. Larry Kimura of the University of Hawaii, an expert in Hawaiian language and naming practices. We described the image to him in detail and he immediately offered a word from the Kumulipo, the ancient Hawaiian creation chant: “Pōwehi.” It means adorned, embellished, fathomless darkness that creates. From its first lines, the chant of the Kumulipo explores the source of all things: “Pō,” the darkness from which everything in the universe was created. It's a perfect name, and a wonder in itself. Now we have the opportunity to bring the deep beauty of Hawaiian scientific and cultural practices to a new audience around the world. And this is just the start. As Dr. Kimura told us, there are more than one hundred descriptions of Pō in the Kumulipo. So, we have some work to do!



*The first image of a blackhole, “Pōwehi,” reveals a glowing ring of light surrounding a black void where gravity is so powerful, even light cannot escape. Courtesy photo: EAO/JCMT.*



## Basalt Sintering Challenges (continued...)



*Two sections of sintered basalt blocks made with varying grain size distribution. The slab on the left was polished.*

### Director's Message (continued...)

The range of technological developments on display was truly a marvel to behold. Adding to the excitement, the entire audience watched a telecast in the exhibit hall of three SpaceX booster rockets landing together—a nearly unthinkable feat just 20 years ago. One of the highlights of the symposium was a closing speech by Sir Richard Branson, founder of the Virgin Group which owns and operates more than 400 companies including Virgin Galactic.

Among the many symposium attendees I spoke with, there were numerous questions about the status of the proposed Pacific Spaceport Complex in East Hawaii with expressed interest in seeing it come to fruition. Hawaii needs to be an active player in this rapidly expanding industry, leveraging its unique geography and resources to help the collective endeavor of space exploration while bolstering the local economy through new industries and job opportunities.

Along these lines, this summer we will be presenting our research work in sintered basalt at the Space Resources Roundtable in Colorado and participate in the International Space Development Conference in Arlington, Virginia. Also this summer, Hawaii's exciting role in space exploration history will be highlighted as part of the 50th anniversary of NASA's Apollo moon landing. PISCES will be supporting public outreach events celebrating this occasion, recognizing Hawaii's role—past, present and future—in exploring the heavens. We hope you'll join us. On a personal note, I'd like to congratulate our Geology Technician Kye Harford and his halau, Hālau Hula 'O Kahikilaulanion, for their 1st place win in the Kane 'auana category and third place in Kane overall during this year's Merrie Monarch Festival. A hui hou,

Rodrigo Romo, PISCES Program Director

She designed a free-floating mold with sealed corners to allow the basalt to compress and expand more. We also altered the grain size distribution of basalt fines by arranging them from coarse to fine layers in the mold, bottom to top. The resulting sintered basalt brick released from the mold without any chipping.

Now that we have this problem solved, we are working on baking ½-inch thick tiles using various grain sizes. Our most recent bake incorporated four different grain sizes, layered from bottom to top and baked under high heat. The resulting tile (pictured left) was then polished with a wet polisher creating a solid and glossy finish like a marble countertop. We're excited to see what kind of applications this product might have. It is extremely durable and could be used for in-situ construction on Earth, or places like the Moon and Mars using surface regolith to build infrastructure.



*The Hawaii delegation who attended the 35<sup>th</sup> Space Symposium in Colorado Springs, Colorado during April.*



*Romo poses with a full-scale model of Lockheed Martin's Orion Capsule outside the symposium exhibit hall.*



# OUTREACH & EDUCATION



## Keaukaha STEM Event Brings Science & Culture to Local Youth

*Top left: PISCES staff and mentors of the PISCES-RISE Robotics Club show students how to remotely control robots to gather plastic spools and stack them on a shelf. Right: Visitors learn about spectrography with Gemini Observatory outreach assistant Alyssa Grace.*

Keaukaha elementary school opened its doors on Tuesday evening, April 23, to invite students and families from the community for an evening of hands-on science, engineering and cultural activities.

Roughly 200 parents and their children attended, many with their eyes and hands focused on fastening, connecting and building objects like mini-robots and battery-operated circuits. Keiki learned about kinetic energy by playing with Matchbox cars, and the techniques of astronomy by viewing different spectrums of light through spectrographic filters. The event also included Hawaiian cultural activities like poi pounding and maritime knot-tying used by Polynesian navigators.

PISCES staff and mentors of the PISCES-RISE Robotics Club for Keaukaha students brought two VexIQ robots and a competition ring where students raced against the clock to stack plastic barrels in a shelf using handheld remotes. The evening family event was also supported by Gemini Observatory, University of Hawaii's Institute for Astronomy (IfA) and the Office of Maunakea Management.

"Keaukaha always has a very good turnout," said Carolyn Kaichi, outreach coordinator for IfA who helps organize the event. "The teachers, parents and children all seem to be interested in and supportive of science. I'm always pleased to see how many parents are so committed to their childrens' education--I can tell by how engaged they are when they assist their kids with the activities."

The evening began as any proper community event in Hawaii should: a reverent pule chanted by two dozen elementary students followed by a complimentary ono dinner.

**Applications are still open for our Summer STARS Program, a Space & Science camp for Hawaii high school girls. Visit our website for details!**

**APPLY NOW AT [WWW.PACIFICSPACECENTER.COM](http://WWW.PACIFICSPACECENTER.COM)**  
 PROGRAM DATES: JUNE 24 - 29  
 DEADLINE TO APPLY: MAY 17



# WORKFORCE DEVELOPMENT



## 2<sup>nd</sup> Annual EMER-GEN Program Returns to AMOS Conference on Maui

*The EMER-GEN Program is designed for young professionals and students enthusiastic about a career in space. Courtesy photo.*

The 2<sup>nd</sup> Annual EMER-GEN™ Program will return to Maui from Sept. 15 to 17 to encourage young professionals with a strong interest in space-related careers. With the help of advisors from industry, government, academia and NGOs, the program involves a two-day experience that offers:

- Mentoring with renowned space specialists from the public sector (military and civil), private sector, and nongovernmental organizations;
- Networking with other young professionals;
- A technical short course presented by a specialist in space situational awareness;
- Professional Development sessions to enhance effectiveness in a global environment.

The mentoring and professional development sessions will guide discussion on key questions and challenges to space cooperation and help the next generation of leaders meet and connect with current leaders and professionals in the industry.

Attending young professionals and students will also be invited to attend the main Advanced Maui Optical and Space (AMOS) surveillance technologies conference at a special rate. AMOS is considered the premiere technical conference in the nation devoted to space surveillance. It will run from Sept. 15 to 17 at the Wailea Beach Resort on Maui.



*EMER-GEN offers mentoring with renowned space specialists from the public sector (military and civil), private sector, and nongovernmental organizations. Courtesy photo.*

For more information about the EMER-GEN program and registration, visit: <http://www.emer-gen.com>. EMER-GEN is a joint-initiative of the AMOS Conference and the Space Generation Advisory Council (SGAC). AMOS is a program of the Maui Economic Development Board, uniting a cross-section of military, contractor and academic participation in the field of space situational awareness.

Maui Economic Development Board, Inc. Presents

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Advanced Maui Optical and Space  
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20  
YEARS

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