

**PISCES Robotic Village: Developing a World Class Test Site for In-Situ Resource Utilization System and Technology Integration.** R.Romo<sup>1</sup>, R.M. Kelso<sup>1</sup>, J.C. Hamilton<sup>1,2</sup>, C.Andersen<sup>1,2</sup>, <sup>1</sup>Pacific International Space Center for Exploration Systems (PISCES), 99 Aupuni St., Ste 212-213, Hilo, HI 96720, [rfvromo@gmail.com](mailto:rfvromo@gmail.com), [rkelso54@gmail.com](mailto:rkelso54@gmail.com); <sup>2</sup> Dept of Physics & Astronomy, University of Hawai'i Hilo, 200 W Kawili St, Hilo, HI 96720, [jch@hawaii.edu](mailto:jch@hawaii.edu), [candarse@hawaii.edu](mailto:candarse@hawaii.edu).

**Introduction:** In-Situ Resource Utilization (ISRU) related to space exploration can be seen as a vertically integrated process that encompasses different technologies throughout all of its stages (orbital reconnaissance & mapping, prospecting, mining/extraction, transporting, processing/separation, storage and finally utilization).

The different technologies involved bring such complexity to the process that it will be practically impossible for a single space agency or non Government Organization (NGO) to develop all the technologies and testing protocols independently. For it to succeed it will require the collaborative work of multiple Space Agencies, NGO's and private companies.

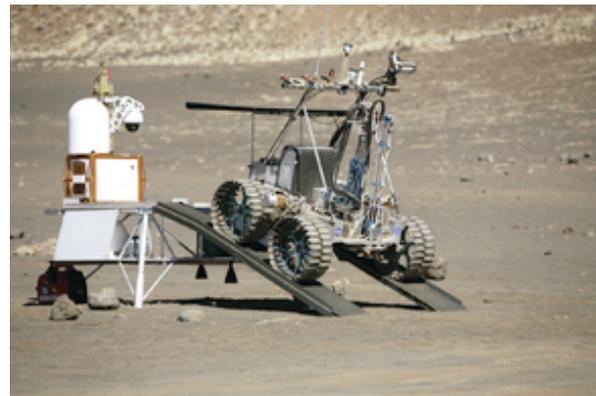
Given the diverse locations of all the players involved, a centrally located test site with geochemical and geological characteristics which closely represent those found on the Moon or Mars would be of great value for the progress of ISRU technology.

The Pacific International Space Center for Exploration Systems (PISCES) in Hilo, HI has embarked in the development of such facility on the Big Island of Hawai'i.

**Background/History:** ISRU tests performed at two different test sites on the slopes of Mauna Kea in 2008, 2010 and 2012 [1][2][3] concluded that the test sites at Mauna Kea provided a "good location for testing strategies for in sit resource exploration at the lunar surface. For drilling purposes the Mauna Kea tephra proved to be ideal testing material".

Based on these previous tests and results, the Pacific International Space Center for Exploration Systems (PISCES) is committed to develop a permanent "Robotic Village" in which different components and technologies that comprise the vertical integration processes for ISRU can be developed and/or tested. The first phase of this project is already on its way and includes the preparation of an ARGO rover provided by Ontario Drive Gear with the same platform as the rover tested in the 2012 Artemis tests. Future stages of the Robotic Village will integrate other projects being worked by PISCES which include 3D laser printing of platforms and shelters using basalt, and LASER based communications. This paper will lay out the multi phase plan for the Robotic Village and detail the future facilities and capabilities that will be made available

on the sites. Some of the areas of development of the Robotic Village will include: rover remote control and autonomous navigation and payload system integration, mineral and geological prospecting, Mating Umbilical Platforms (MUP's), oxygen and water extraction from regolith, renewable energy, water purification and reutilization, hardware wear and tear, dust control and mitigation, and lava tube and skylight mapping and exploration.



#### References:

- [1] Captain, J., Quinn, J., Moss, T., "RESOLVE's Field Demonstration on Mauna Kea, Hawaii 2010", AIAA Space 2010 Conference & Exposition. 30 August – 2 September 2010, Anaheim, CA.[2] Kate, I.L., Armstrong, R., Bernhard, B., Blumers, M/. Craft, J., Boucher, D., Caillibot, E., Captain, J., Deleuterio, G., Farmer, J.D., Glavin, D.P., Graff, T., Hamilton, J.C., Klingelhofer, G., Morris, R.M., Nunez, J., Quinn, J.W., Sanders, G.B., Sellar, R.G., Sigurdson, L., Taylor, R., Zacny, K. "Mauna Kea, Hawaii, as an Analog Site for Future Planetary Resource Exploration: Results from the 2010 ILSO-ISRU Field-Testing Campaign". Journal of Aerospace Engineering, January 2013.[3] Visscher, P., Picard, M., Smith, J., Boucher, D., Cristello, N. "Artemis Jr. Rover Mobility Platform". 51<sup>st</sup> AIAA Aerospace Sciences Meeting including the New Horizon Forum and Aerospace Exposition. Grapevine, TX, January 07-10, 2013