FINESSE (Field Investigations to Enable Solar System Science and Exploration): Overview of Science and Exploration Research to Enable Lunar and Planetary Exploration. J. L. Heldmann[1], D. S. S. Lim[1], A. C. Colaprete[1], A. Sehlke[1,2], R. C. Elphic[1], D. Sears[1,2], and the FINESSE Team. [1]NASA Ames Research Center, Moffett Field, CA, [2]BAER Institute, Moffett Field, CA. Science Topic = Analog Research.

Introduction: The FINESSE (Field Investigations to Enable Solar System Science and Exploration) project is an Ames-led research program administered by NASA's SSERVI (Solar System Exploration Research Virtual Institute). FINESSE is in its fifth and final year of operations and here we provide an overview of the science and exploration research conducted to date.

FINESSE Overview: FINESSE is an interdisciplinary team of scientists, technologists, and mission operations specialists focused on conducting field-based research to understand geologic processes on the Moon, asteroids, and Phobos & Deimos while simultaneously preparing for future human and robotic exploration of these destinations. FINESSE includes team members from government, academia, and industry, including both domestic and international partners. Participating institutions include multiple NASA Centers (Ames, Goddard, Kennedy, Johnson, JPL, and Marshall), 16 universities, and 9 research and private organization (including the Canadian Space Agency and international partners Canada, UK, and Korea). We have over 70 team members and FINESSE-supported fieldwork has been conducted at Craters of the Moon National Monument and Preserve in Idaho, the West Clearwater Lake Impact Structure in northern Canada, the volcanic fields of Hawaii, and newly erupted volcanic landscapes in Iceland. We operate under the philosophy that "*science enables exploration and exploration enables science*."

Science and Exploration Research. Multiple research projects pertaining to the geologic processes of impact cratering and volcanism have been completed this year by the FINESSE project. We seek to understand volcanics and impact cratering as the two dominant geologic processes shaping the landscapes of the Moon, asteroids, and Phobos & Deimos. In addition to our scientific research, we have conducted field-based research to optimize the science return and operations for future robotic and human missions. Selected highlights from these research activities are presented here.

Science: Impact Cratering. Field, laboratory, and modeling work has shed light on impact cratering in the inner solar system. Key findings include how shock processes deform rocks during impacts, and how our canonical interpretation of rock types at impact sites requires revision to accurately understand how impact craters form in the Solar System. Also, by age dating the West Clearwater Impact Structure rock samples, we've learned that age-dating of impact craters will require a large number of returned samples collected from a broad area within the impact site for future planetary geochronology missions, and also that the East and West Clearwater impacts, surprisingly, have different ages.

Science: Volcanism. FINESSE research has studied the rheology of terrestrial and lunar lava analogs and implications for sinuous rille formation on the Moon. Our data suggest that thermo-mechanical erosion is only a viable construction mechanism for sinuous rilles as long as lavas remain in turbulent flow regimes above and/or around their liquidus temperature. We've conducted new laboratory experiments at the Syracuse Lava Project where basalt is melted into lava and solidifies to form volcanic rock and quantified emplacement temperatures and cooling trends plus lava accumulation rates. Thermal properties and surface roughness of lava flows have also been correlated with volcanic emplacement and evolution.

Handheld Field Instruments for Human Exploration. Handheld instrumentation capable of *in-situ* analyses require evaluation for their usefulness for human exploration missions to other planets. FINESSE has acquired several handheld spectrometers, a visible-near infrared (vis-NIR), a X-Ray-Fluorescence (XRF), and a Laser Induced Breakdown (LIB) spectrometer, as well as a FLIR (forward looking infrared) camera system. We studied how to best implement these new technologies, which were not available during the Apollo missions, during simulated exploration missions conducted on basaltic terrains in Idaho, Hawaii, and Iceland. We'll discuss these instruments which are available for use within the Ames community.

Education and Public Outreach. FINESSE is committed to inspiring the next generation to pursue careers in planetary science and exploration. To that end, we have run the Spaceward Bound program for multiple years to bring students and teachers into the field to conduct research in Craters of the Moon National Monument and Preserve. Spaceward Bound participants work side-by-side with NASA researchers, operating field instruments, collecting data, participating in science discussions, and contributing to scientific publications. We also support the TATERTOTS (Training in Advanced Technology and Exploration Research to Optimize Teamwork in Space), a team of undergraduate students from the University of Idaho who launched an instrumented high altitude balloon in support of FINESSE planetary-analog lava tube re-

search in Idaho. We also support numerous additional events such as a the NASA Museum Alliance, Solar System Ambassadors, and countless outreach events.