LESSONS LEARNED IN THE SCIENCE EVALUATION ROOM AS PART OF THE JOINT EVA TEST TEAM FIELD TEST 3 (JETT3). S. R. Jacob[1*], C. N. Achilles[2], E. R. Bell[3,2], A. W. Britton[4,5], B. A. Cohen[2], L. A. Edgar[6], A. L. Fagan[7], A. H. Garcia[4,5], W. B. Garry[2], T. G. Graff[4,5], J. M. Hurtado[8], J. A. Richardson[2], S. E. K. Nawotniak[9], J. A. Skinner, Jr.[6], C. M. Trainor[4,5], A. R. Yingst[10], K. E. Young[2]. [1]Arizona State University, Tempe AZ (*samantha.jacob@asu.edu); [2]NASA GSFC, Greenbelt, MD; [3]UMCP, College Park, MD; [4]NASA JSC, Houston, TX; [5]Jacobs, Houston, TX; [6]USGS Astrogeology, Flagstaff, AZ; [7]WCU, Cullowhee, NC; [8]UTEP, El Paso, TX; [9]ISU, Pocatello, ID; [10]PSI, Tucson, AZ.

JETT3 Science Evaluation Room: In spring 2022, a group of scientists were competitively selected to participate as members of the JETT3 Science Team (including those who would serve either in the Science Evaluation Room (SER) during the mission or on the Science Field Team (SFT)) for the third analog test of the Joint Extravehicular Activity (EVA) Test Team (JETT3). In Oct. 2022, the SER members met at Johnson Space Center in Houston, TX and were integrated as part of the Flight Control Team (FCT) for the field campaign. Two members of the full science team were assigned to be part of the field crew that followed the two EV crew members in the field [4]. The field campaign consisted of 2 four-hour and 2 six-hour traverses (EVAs [5]). The field area consisted of a 2 km radius ellipse and was located east of SP Mountain near Flagstaff, AZ. This abstract describes the science documents created by the science team, new science that was learned by the SER members during the field campaign, and lessons learned throughout the entire JETT3 test.

Science Planning Documents: Prior to the Oct. 2022 field campaign, the full science team (SER and SFT personnel) met virtually to define the science objectives for the field test and generate products including a Science Traceability Matrix (STM [1]), geologic map [2], station identification [1,3], traverse plans [3], and documents to track samples, crew locations, and evolving geologic hypotheses. Preliminary science interpretations were made based on orbital data, and traverses were designed to address outstanding questions and return a representative suite of rock and regolith samples. The overarching science goal of JETT3 was to characterize the formation and evolution of geologic units in the JETT3 landing ellipse. The JETT3 STM was organized into four broad categories: volcanism, surface processes, tectonic processes, and age relationships. Initially the STM included a fifth category of volatiles as the JETT3 test had an imposed objective of simulating the collection of a volatile sample at an arbitrarily selected Permanently Shadowed Region (PSR). While the sample collection was simulated in order to practice this high value Artemis III objective, the final JETT3 STM did not include this objective. Each JETT3 STM goal had multiple objectives, each of which was tied to crew actions, sampling activities, and field observations that would be required to assess the objective. Prior to the field simulation, the science team identified and prioritized stations that were relevant to addressing each objective. The highest priority stations were selected based on their potential to address multiple objectives and STM goals.

The science team also generated several documents that were used to support the real-time SER operations, including a Science Play-by-Play (essentially a science console log to quickly track crew activities), a Science Documentation Log (which contained screenshots and longer summaries of crew science activities), a tracking spreadsheet (to document as-executed sample, observation, and imagery activities against the planned actions), and a map layer to track SER estimation of crew location.

Science and Lessons Learned in the SER: Thanks to the hard work and determination of the JETT3 crew members (astronauts Drew Feustel and Zena Cardman), the science team was able to make numerous evidence-based interpretations about the geology of the field area (Table 1). Prior to the field campaign, the science team had mapped out various volcanic flows, massifs, and surficial units [2]. During the field campaign, various observations allowed the SER to refine age relationships and document new geologic units that could not be identified in orbital data. The SER identified a unit they named AU – alluvium undifferentiated, located in a valley explored during EVA2. This surficial unit was made of loose material eroded from the surrounding volcanic flow and massif. Because of the fast-paced tactical observations the SER also misidentified a continuous band of caliche that was initially observed during EVA1 (Fig. 1) but was seen again on EVA3. While the caliche was imaged and sampled on EVA1, limited time meant the field crew was unable to identify the lateral extent and character of the caliche. The SER initially described the caliche as alteration material on the volcanic flow that was being explored.

One of the lessons learned during JETT3 is the need for a strategic science team that would come in after each EVA to understand how the field observations changed or confirmed the science team's initial hypotheses and then communicate those discoveries to the tactical science team supporting the EVAs. While

there was some replanning of traverses throughout the field campaign, this was done mostly on the basis of stations and samples that were missed in previous traverses, not necessarily based on science discoveries due to the lack of a strategic science team. With the size of the JETT3 science team, only the tactical science team was possible, and most of the time in the SER was spent focused on tactical planning and replanning [6], and there was limited time for strategic geologic interpretations. Regardless of the limited strategic science time, the SER members were able to make some new discoveries for each science goal identified in the STM (Table 1). These discoveries came from quick examinations of the crew video and images [7]. Samples taken throughout each EVA have and will likely continue to confirm various hypotheses from the JETT3 science team. Evaluation of the field data and samples is still ongoing.

JETT3 obstacles: There were several obstacles encountered throughout the field campaign that required re-planning and/or adjustment by SER and crew. The biggest obstacle that could prove detrimental to science return during future Artemis missions is navigating and geolocating [8] based on dead reckoning. Location estimate inaccuracies were especially problematic during EVA2 when the crew worked to find the location of the simulated PSR. The initial location the crew wanted to stop for sampling was 200+ m away from the planned station, and the post-test debrief demonstrated that the crew never reached the simulated PSR despite the crew and SER estimating that they had reached their destination. Other obstacles encountered in the SER included how to document and map crew observations and how to communicate these notes outside of the SER. The SER scrum ultimately annotated printed maps to document crew observations and estimated locations. Another obstacle that inhibited our strategic planning was the delay in receiving crew images. The SER did not receive the crew field images until the next day. For Artemis missions, real time image downlink would be ideal for the science team.

Conclusions: With the launch of Artemis 1, the return of humans to the lunar surface is fast approaching. Analog tests like JETT3 are critical for learning how to let science discovery lead the planning efforts for future Artemis missions. The JETT3 test was the first to integrate a science back room into the full flight control structure. Further testing will be necessary to continue training scientists and flight controllers to work together to achieve the best science possible during human exploration missions.

Acknowledgments: The authors thank the entire JETT3 team, which included 100+ engineers, flight controllers, astronauts, scientists, and more. This work was supported by *Analog Activities to Support Artemis Lunar Operations Desert RATS 2022*.

References: [1] Fagan et al. (2023) *LPSC 54*. [2] Skinner et al. (2023) *LPSC 54.* [3] Young et al. (2023) *LPSC 54.* [4] Edgar et al. (2023) *LPSC 54*. [5] Caswell et al. (2023) *LPSC 54*. [6] Kobs Nowatniak et al., (2023) *LPSC 54*. [7] Hurtado et al., (2023) *LPSC 54*. [8] Richardson et al., (2023) *LPSC 54*.

Figure 1: Crew images of the misidentified caliche beds. Top: EVA1, Bottom: EVA3.

Table 1: Goals and outcomes, as perceived by the SER

STM Goal	New Science Discovery
Volcanology	Confirmed hypothesis that two individually mapped lava flows are the same unit.
Surface Processes	Identified a new unit, alluvial undifferentiated (AU), likely material that eroded off the southern massif and nearby volcanic flow.
Tectonic Processes	Crew reported instances of breccias on EVA3, could be fault breccia.
Age Relationships	Crew determined age relationship of sediment and volcanic flow.