DOCUMENTING OF GEOLOGIC FIELD ACTIVITIES IN REAL-TIME IN FOUR DIMENSIONS: APOLLO 17 AS A CASE STUDY FOR TERRESTRIAL ANALOGUES AND FUTURE EXPLORATION. B. Feist[1], J. E. Bleacher[2], N. E. Petro[2] and P. B. Niles[3], [1]Jacobs Technology Inc. (bf@benfeist.com), [2]Planetary Geology, Geophysics, and Geochemistry Lab, NASA Goddard Space Flight Center [3]NASA Johnson Space Center

Introduction: During the Apollo exploration of the lunar surface, thousands of still images, 16 mm videos, TV footage, samples, and surface experiments were captured and collected. In addition, observations and descriptions of what was observed was radioed to Mission Control as part of standard communications and subsequently transcribed. The archive of this material represents perhaps the best recorded set of geologic field campaigns and will serve as the example of how to conduct field work on other planetary bodies for decades to come. However, that archive of material exists in disparate locations and formats with varying levels of completeness, making it not easily cross-referenceable. While video and audio exist for the missions, it is not time synchronized, and images taken during the missions are not time or location tagged [e.g., 1]. Sample data, while robust, is not easily available in a context of where the samples were collected [2], their descriptions by the astronauts are not connected to them, or the video footage of their collection (if available).

A more than five year undertaking to reconstruct and reconcile the Apollo 17 mission archive, from launch through splashdown, has generated an integrated record of the entire mission, resulting in searchable, synchronized image, voice, and video data, with geologic context provided at the time each sample was collected. Through www.apollo17.org the documentation of the field investigation conducted by the Apollo 17 crew is presented in chronologic sequence (Figure 1), with additional context provided by high-resolution Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Camera (NAC) images and a corresponding digital terrain model (DTM) [3] of the Taurus-Littrow Valley.

Establishing a Temporal Thread Across Disparate Datatypes:

The effort to create this archive required not only the compilation of all available audio, video, image, and sample data, it required the transcript for the mission to be organized, time-corrected, and content-corrected for context and speaker. With this and the concurrent audio recordings synchronized, organizing available video (either TV or onboard 16 mm footage) and time stamping that material, all ~12.5 days of the mission is available to play in real-time. With the above time correlation completed, it became possible to place the mission images in as near time context as possible. Some images correlate directly to video or film content and can be timed precisely, others with less precision. Lastly, the 410 surface samples collected by the crew were precisely timed using the bag numbers announced by the crew at the time of collection cross referenced with the lunar sample numbers assigned by the Lunar Sample Laboratory Facility.

Apollo 17 Field Activities in Context: For ~3 days, the Apollo 17 mission conducted the most recent field exploration of another planetary body when Astronauts Cernan and Schmitt explored the valley of Taurus-Littrow. During their stay, they conducted three EVA's, took 3,651 images while on the surface, collected 110.52 kg of rock and soil samples, traversed 35.74 km, and deployed 10 surface experiments. During their EVAs the astronauts reported detailed observations of their surroundings, essentially making verbal field notes, while conducting their sampling and photo-documentation. However, each of these aspects of their exploration had not been placed together, making difficult the integration of their observations along with the image and video documentation. With the apollo17.org archive of the mission, each aspect of the mission is brought together. For example, the observations of a number of similar small boulders at Station 8 with the exception of a larger boulder uphill from the LRV reinforces the uniqueness of the sample and its likely origin from further up slope in the Sculptured Hills (http://apollo17.org?t=166:52:10) [4]. The complete documentation of the collection of these samples (78135, 78238, 78255) enhances the context with which they were collected.

Application to Future Analogues and Missions: The effort to generate the apollo17.org archive has produced a number of recommendations for future analogue studies or crewed missions that were recently applied during a field analog test in the Potrillo Volcano field of New Mexico, supported by the SSERVI RIS[4]E team [5]. The following principles were applied:

1. *Timing:* All data (image, video, voice, and scientific) needs to be time synchronized to high precision. During analogue tests this was accomplished by imaging a common clock.
2. *Spatial Context:* Accurate GPS tracking (for terrestrial tests) or photo-documentation of traverses provides detail on where actives occur [6,7], and enable placing the activities in context with other remote sensing datasets such as aerial imaging.

3. *Sample Collection:* As part of both the timing and spatial context is placing samples collected into their proper context. For Apollo 17 this is done by connecting any mention by the crew of sample bag to their resultant samples. Similarly, in analogue tests, each sample is tagged based on the time and location of their collection.

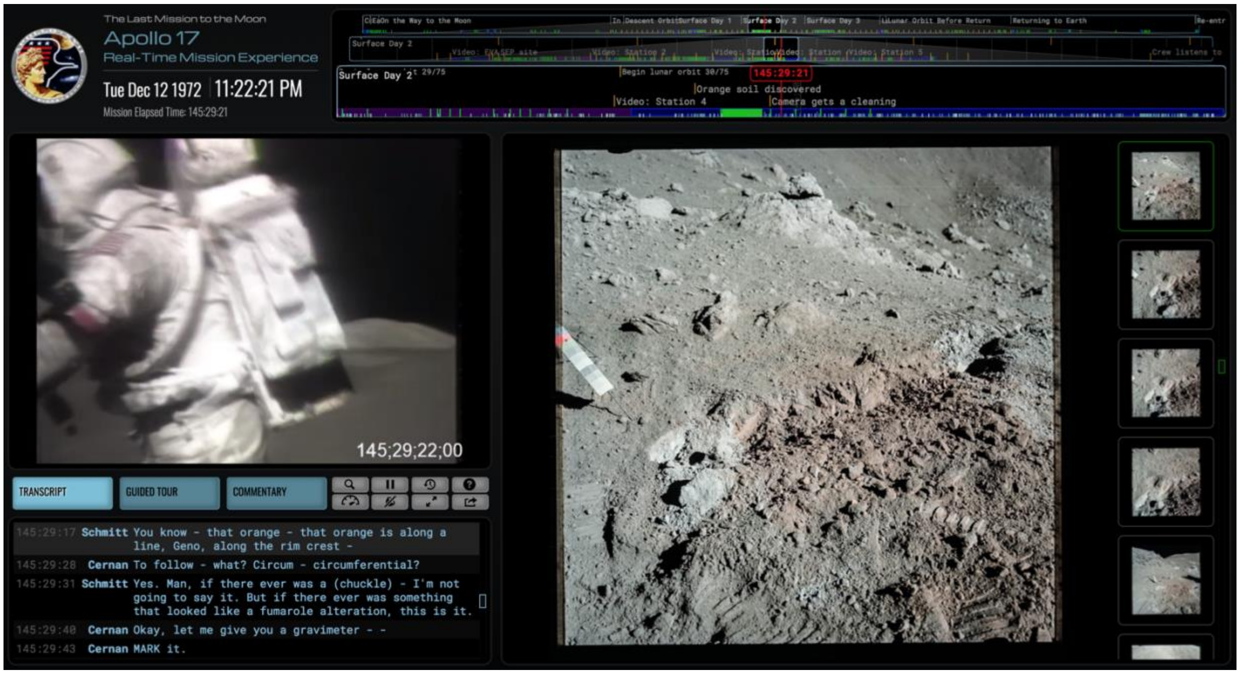

Figure 1. Capture of apollo17.org interface of the moment of documenting the orange soil at Station 4. At that moment the crew had identified the orange soil and were preparing a revised sampling plan (apollo17.org?t=145:29:17)
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4. *Data collection:* In Apollo 17 the crew deployed ALSEP experiments at the start of EVA and supported ongoing traverse gravimeter measurements. However, in future exploration the crews may collect data via portable hand-held instruments or regularly deployed instruments during traverses. Such collected data similarly needs to be accurately time-tagged, which places requirements on the development of such instruments. Similarly, regular calibration can aid in providing accurate timestamps.

Public Reception and Impact of Temporal Data Presentation: The public release of Apollo17.org had the unexpected outcome of receiving public attention. Since its release, over 500,000 unique visitors have spent an average of 10 minutes engaging with the historical content. Television stations and news publications have written many articles about apollo17.org, crediting it for bringing the Apollo program to life for a new generation. We have shown that the repackaging of already available data into a temporal experience is an effective new way to engage the public on scientific endeavors.

Historical Open Data as an Analog for Future Data Gathering: As an Open Data initiative, this newly constructed Apollo 17 data archive serves as a representation of the desired data structure of future analogue field activities and indeed for future exploration missions. Apollo17.org is an illustration of one way to visualize the resulting temporally structured archive and hints at the new types of research possible with the simultaneous analysis of cross disciplinary data. However, the underlying data is decoupled from the illustrative interface and provides fertile ground for research involving other types of data analysis.

References:
[1] Apollo Lunar Surface Journal, (http://history.nasa.gov/alsj/frame.html). [2] Lunar Sample Compendium, (http://curator.jsc.nasa.gov/lunar/compendium.cfm). [3] Henriksen, M. R., et al., (2017) *Icarus*, 283, 122-137. [4] Schmitt, H. H., et al., (2017) *Icarus*, 298, 2-33. [5] Wright, K. (2017) http://www.aps.org/publications/apsnews/201712/flood.cfm [6] Wagner, R. V., et al., (2017) *Icarus*, 283, 92-103. [7] Haase, I., et al., (2012) *Journal of Geophysical Research: Planets*, 117.