Apollo in the Field: Breakthrough and Baseline for Future Planetary Surface Exploration. P.E. Clark; CUA@NASA/GSFC, Greenbelt, MD 20771 (pamela.e.clark@nasa.gov).

Apollo Approach to Field Work: The extraordinary challenge field geologists faced in planning the first human expeditions to the surface of another solar system body led to the development of a new and distinctive approach to geological field work [1]. Not An extensive archive of the Apollo era science activity related documents [2] provides evidence of the principal aspects and keys to the success of the field work. The Apollo Surface Journal [3] allows analysis of the astronaut's actual performance in terms of capability for distance on foot, documentation and sampling of field stations, and manual operation of tools and instruments, all as a function of time. The application of these analysis as 'lessons learned' for planning the next generation of field science activities on the Moon and elsewhere are considered here as well.

Constraints and Requirements: Robotic precursors had to provide 'on the ground' images and orbital coverage at up to 1 meter resolution for potential landing sites would be essential. The astronauts relied on intensive simulation and training [e.g., 4] and the innovative use of a co-trained geological 'back room'. The astronauts had to be successful at capturing the geological character of the site accurately and succinctly the first and only time, despite the fact that they had very little time (3 EVAs of up to 24 hours in the field for the later J missions). The astronauts were restricted to tens of kilometers in the rover and normally tens of meters on foot.

Equipment: Fortunately, geological surface sample collection tools [9], including rock hammer and chisel, tongs, rake and shovel, lend themselves to easy handling, but even these were optimized for use in the gloved hand of the astronaut. Scoops were added for the collection of representative regolith samples. Most problematic were the subsurface sampling devices, including manual shallow drive tubes (20-30 centimeters) and the powered regolith drill (up to 2 meters in 40 cm stem sections) and designs were modified subsequent to first use on the Moon.

Documentation: Obviously, the indispensable geological field notebook, requiring use of a writing implement and both hands, was not practical [10]. Training played a crucial role in producing articulate, systematic, logical, flexible audio streaming to provide geological context in a common language accompanied with panoramic/portrait photos to confirm position and context of collected samples numbered for later use.

Sampling and Site Characterization: Systematic yet flexible sampling accompanied by documentation was the primary geological activity. Major sampling stations, typically boulders, were planned ahead of time and dictated the traverse. Astronauts had been trained to minimize the time required for sample collection during their training, which involved time motion studies [8]. At a typical station, 3 to 4 prime sampling sites were reachable on foot from the rover, separated by tens of meters. Sampling at a site typically took 15 to 20 minutes and was repeated for each sampling site [1]. Systematic sampling typically involved sampling soils and rock fragments around and under a boulder as well as obtaining chips of the boulder or rocks on the ground that apparently originated from it. During the course of each of the day's traverse, astronauts typically gathered 30 to 35 kg of samples from 4 to 5 major stations, averaging between 7 and 8 kg per station. The Apollo astronauts used an unpressurized rover to travel distances of up to 25 to 30 km during the course of a traverse during an EVA. They spent about half of their time at the stations, and the rest driving. This pattern was developed during their training with a simulated rover [3,8].

Application for Future Field Work: A much greater variety of instruments can be use dto generate 'baseline' maps. We certainly have a greater capability for streaming audio, video, and instrument feeds, and for hands free operation. Rover-mounted instrumentments could provide local remote sensing along traverses. In fact, we could easily generate too much information for anyone to process in real time, as indicated by the Apollo experience. None of these capabilities mitigate the need for efficient, systematic documentation and sampling methodology, as used on Apollo. In fact, the need is more critical, because of the limited mass available for sample return, translating into the need for down-selecting samples of potential interest in situ, through the use of new portable analysis tools, as an additional step in the sampling and site characterization process.

References: [1] Clark, 2010, GSA Bulletin, in publication; [2] Schaber, 2005, USGS Open File Report 2005-1190; [3] NASA History Office, accessed 2010, Apollo Lunar Surface Journal website; [4] England et al, 1971, Traverse Briefing for the Apollo 16 Crew; [8] Bailey et al, 1967, Apollo Applications Program Field Test 8 with Section on Task Analysis, USGS Technical Letter 26; [9] Allton; 1989, Catalog of Apollo Lunar Surface Geological Sampling Tools and Containers, JSC-23454/LESC-26676; [10] M'Gonigle et al, 1969, A proposed scheme for lunar geologic description, USGS Interagency report: Astrogeology 18.