THE ROASTT-2017 TRAINING EXERCISE FOR THE MARS 2020 SCIENCE TEAM  R. Francis¹, K. Williford¹, K. M. Stack¹, N. Spanovich¹, S. Milkovich¹, F. Calef¹, Jet Propulsion Laboratory, California Institute of Technology (Contact: raymond.francis@jpl.nasa.gov)

Introduction: The Mars 2020 rover mission has an ambitious set of goals, including: (1) exploring the geology and habitability of the rover’s landing site, (2) seeking signs of ancient life, (3) collecting 20 geological samples from well-characterized localities for possible return to Earth, and (4) preparing for human exploration on Mars. The scope of Mars 2020’s mission objectives will require unprecedented mission productivity, and has motivated changes to a number of aspects of the surface mission, including the processes for surface science operations. The Mars 2020 Science Team needs to be comfortable with working as an integrated team to make decisions within this operational framework, and to “hit the ground running” upon landing. Thus, the Mars 2020 Science Office has begun a series of training exercises, termed Rover Operations Activities for Strategic and Campaign Planning (ROASTT), the first of which took place in October and November of 2017. These training exercises are designed to allow members of the science team to practice working together, making science decisions, and experiencing the operations processes in the context of actual field sites and science data.

Strategic and Campaign Planning: Science operations planning for Mars 2020 is structured to progress in stages from large to small geographic areas, months ahead to daily time scales, and from broad to specific science objectives. The first stage, termed Strategic planning, involves assessing and prioritizing identified regions of interest (ROI) within the rover’s landing site and selecting within them targeted “campaign” locations for detailed geological study. The high-level plan for exploration of each campaign location, including identification of key rover stops and their durations, is then planned out in a process termed Campaign Planning. The detailed plan for each sol of the campaign, including changes and updates based on fresh rover data, is then carried out in daily operations by subsequent operations processes.

The Strategic and Campaign Planning activities for the Mars 2020 surface mission will begin prior to the rover’s arrival at the areas to be explored; some advanced planning will even occur prior to the rover’s landing. The intent is to have a workable high-level exploration plan ready by the time the rover arrives at the area to be explored. As a result, much of the planning will rely on information about the regions of interest obtained from orbital imaging.

Exercise goals: The 2017 exercise focused on the Strategic and Campaign Planning processes, and had five central goals:
- Familiarizing the science team with the ops process
- Practicing geological interpretation and exploration planning using orbital data
- Testing the dynamics of interactions between subgroups in the mission planning process
- Introducing the science team to the scope, content, and structure of a campaign plan, and the tools used to develop it
- Teambuilding and working interaction between the members of the science team

Exercise design: ROASTT-2017 was designed to simulate the work and interactions of the science team and the dedicated Campaign Planning Science Group (CPSG) which would undertake the planning of one of the geological campaigns at a selected area. An analogue site in the south Bristol Mountains within Mojave Trails National Monument was used as a stand-in for the Mars 2020 landing site, though its location and geology were not revealed to the participants during the exercise.

The exercise began with a kickoff briefing and training session for participants, held as a teleconference. At the same time, the online repository of mission planning data became available – ‘orbital’ datasets, and a single “rover” image of the terrain at the landing site. The teams had one month to review, analyze, and discuss the datasets, during which time a discussion and tutorial session with an orbital interpretation specialist was provided, and a Science Discussion telecon was scheduled to allow members to present their work, interpretations, and mapping efforts.

Figure 1. A view of the proposed campaign area, with drive route, key stops, and localities of interest (‘camp sites’) marked.

Following this, the science team met in-person and via remote call-in for a 5-day period, the first day and a
half of which were dedicated to completing the Strategic planning process. The remainder of the exercise saw a subset of participants (approximately 25, varying over the week) work as the CPSG to plan the exploration of the campaign location chosen in the Strategic process (Figure 1), reporting out to the broader science team at Science Discussion meetings throughout the week. On the fourth day of the in-person exercise, the team was provided with the first set of ‘rover’ images from the ROI, including two color image panoramas along the rover’s planned path towards the campaign location. This allowed the team to practice updating the campaign map (Figure 1) and high-level sol path (Figure 2) in response to images from the surface as the rover approaches the campaign area and to feedback from the broader science team.

The exercise concluded with a field trip to the selected analogue site, to allow participants to see and interpret the area first-hand, and compare it with their expectations from orbital data.

**Tools:** The team was provided with a preliminary version of the Mars 2020 Campaign Analysis Mapping Planning (CAMP) tool, which allows visualization of orbital and in-situ datasets from the rover, as well as mapping and annotation of areas and locations of interest. Filesharing and teleconferencing tools were made available, and large printouts of the orbital datasets were provided in the room used by the CPSG. The orbital datasets included:

- High resolution 25 cm/pixel color and greyscale imaging equivalent to HiRISE
- Regional 6 m/px greyscale imaging similar to CTX
- 30 m/pixel spectral parameter map like CRISM
- 1m/pixel slope map comparable to what rover planners use for strategic route planning

**Outcomes:** The team completed the Strategic and Campaign planning tasks, selecting a campaign area, developing testable geologic hypotheses, then planning a geological investigation using the rover’s instrument payload to make those observations and collect samples over 110 sols of mission time. This Campaign Plan included, as key elements:

- A statement of the campaign goals, and hypotheses about the environment to be explored
- A list of key stops and localities of interest (termed ‘campsites’)
- The approximate drive route for the rover
- A ‘High Level Sol Path’, representing overall types of activities to be undertaken on each sol of the campaign (eg driving, remote sensing, sampling, etc.)

The post-exercise field trip allowed members of the science team to see the field site in person, and field interpretations made then coincided with one of the proposed hypotheses about the nature of the site.

**Upcoming activities:** The Mars 2020 Science Office is preparing a continuing series of training exercises in the ROASTT series, over the years leading up to the surface mission. These will focus on other aspects of the mission operations process, including daily operations to select and prepare activities for the rover on a per-sol basis as the mission progresses.