

# Expedition One Geology Program

The Expedition One Geology Program follows 4 phases of study. Each phase is progressively linked to the overall program, in order to refine and develop a scenario for conducting geological research on Mars. Phase One is focused on EVA Exploration Operations – learning what are the most effective tools, technologies, and strategies for scouting various terrains for the geological features of interest on Mars. Phase Two is focused on EVA Science Operations – learning what are the most effective procedures and strategies for detailed investigations of specific sites on Mars for their geologic interest. Phase Three is focused on Mars-Analog Science – obtaining data from the desert environment to conduct Mars-analog geological studies. Phase Four is focusing on integrating the Mission Science Scenario – conducting a mixture of scouting and surveying to obtain the data for Mars-analog studies, and learning how to develop an effective mission science plan for Mars.

The first phase starts at the deepest level of goals, and subsequent phases pursue higher goals.

Level Zero: the geological goals.

Level One: products of the geological goals.

Level Two: investigating what data are we collecting, what actions do we need to produce.

Level Three: investigating what specific human skills are required to obtain the data desired and to deliver the actions desired; and how to technologically obtain the data desired and how to deliver the actions desired.

The program goals are:

1. Develop an understanding of the variety of regolith in the area
  - i. Produce regolith-landform maps of the area
    - a. Investigate the operational requirements of verifying each site for accuracy of regolith and landform interpretation – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
2. Develop a detailed understanding of the stratigraphy and structures of the region.
  - i. Map the structures and lithofacies in the region
    - a. Investigate the operational requirement for mapping structures and lithofacies – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.

- iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
    - v. Investigate options for sampling and measuring instruments specific to this science goal.
  - ii. Develop a structural model of the sedimentary basin in the region
    - a. Investigate the operational requirements for laboratory construction of a structural model – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
  - iii. Obtain measured stratigraphic sections
    - a. Investigate the operational requirements for obtaining sections of strata – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
- 3. Develop an understanding of the depositional and diagenetic history of the succession.
  - i. Study gypsum deposits to determine their origin
    - a. Investigate the operational requirements for studying gypsum deposits – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
  - ii. Obtain paleocurrent measurements from cross bedding, ripples, imbrication, tool marks, and flute casts.
    - a. Study the operational requirements for obtaining paleocurrent measurements from each type of geological feature – what observations need to be made, what samples collected, what measurements to be taken?

- i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
    - iii. Interpret paleoenvironments from the bedrocks
      - a. Study the operational requirements for interpreting paleoenvironments from the bedrocks – what observations need to be made, what samples collected, what measurements to be taken?
        - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
        - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
        - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
        - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
        - v. Investigate options for sampling and measuring instruments specific to this science goal.
    - iv. Investigate the nature of weathering horizons and paleosols in the stratigraphic succession.
      - a. Study the operational requirements for determining the nature of weathering horizons and paleosols in the strata – what observations need to be made, what samples collected, what measurements to be taken?
        - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
        - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
        - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
        - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
        - v. Investigate options for sampling and measuring instruments specific to this science goal.
4. Develop an understanding of igneous processes in the region
- i. Map and sample igneous dikes in the region, and determine if they are shallow or radial.
    - a. Study the operational requirements for mapping and sampling igneous dikes – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.

- ii. Collect a representative suite of igneous rocks in the region.
    - a. Study the operational requirements for collecting a suite of igneous rocks – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
5. Develop an understanding of the landscape history
- i. Study the geomorphology of the region.
    - a. Study the operational requirements for performing geomorphology studies – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
  - ii. Study fluvial processes – channels, flood plains, etc.
    - a. Study the operational requirements for fluvial studies – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.
  - iii. Study past and present aeolian processes – dunes, dust mantles, and dust devils.
    - a. Study the operational requirements for aeolian studies – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.

6. Develop an understanding of water chemistry in the area
  - i. Create a database of salinity and pH of the surface water and groundwater seeps.
    - a. Study the operational requirements for water chemistry studies – what observations need to be made, what samples collected, what measurements to be taken?
      - i. Investigate different traverse strategies for efficient scouting or surveying specific to this science goal.
      - ii. Investigate vehicle mobility options for scouting or surveying specific to this science goal.
      - iii. Investigate data-logging options for scouting or surveying specific to this science goal.
      - iv. Investigate spacesuit dexterity requirements for scouting or surveying specific to this science goal.
      - v. Investigate options for sampling and measuring instruments specific to this science goal.