Mineral identification near Nili Fossae using CRISM followed three criteria: (1) absorption features in spectra should be consistent with those in library spectra, (2) features should not be consistent with other minerals (uniqueness), and (3) no strong absorptions should be left unexplained. Minerals identified include Fe/Mg smectites (most common), Fe-rich chlorite, prehnite, serpentine, kaolinite, illite/muscovite, analcime, hydrated silica, and magnesium carbonate.

**Eastern Province**
- Stratigraphy from bottom to top generally seen as Fe/Mg smectites (layered and contained within megabreccia), olivine-bearing rocks which sometimes contain carbonate (associated with in place stratigraphy and transported sediment), and cap rock
- Kaolinite, less common in the east, is thought to pre-date at least the last tectonic event causing the fossae opening because the fossae cut the stratigraphy (kaolinite always overlies Fe/Mg smectites, does not appear to be bedded, and is very bright)
- Hydrated minerals are associated with in place stratigraphy as well as transported sediment
- Serpentine is associated with olivine and carbonate-bearing rocks or doesn’t correlate with any stratigraphy

**Western Cratered Province**
- Smectite and chlorite appear in blocks and matrix material, where chlorite is not associated with prehnite

Janette Wilson, April 20, 2011

- Analcime found within craters and around central peaks
- Hydrated silica is found in mobile materials

Central Province
- Smectites less prevalent, with chlorite and prehnite being dominantly exposed in rocky knobs, small craters, and polygons
- Northernmost craters have K-mica, while southernmost craters have hydrated silica or kaolinite outside the crater

There have been multiple episodes of aqueous activity from the Early Noachian to the Late Hesperian: (1) alteration to form Fe/Mg smectites, (2) alteration to form kaolinite or magnesium carbonate, and (3) erosion of both units by fluvial activity. The spatial extent of the Fe/Mg smectites calls for a large-scale formation mechanism such as (top-down) leaching, which could have also formed the kaolinite. These materials likely altered over a period of thousands of years. Parent rock composition seems to be the control on the formation of either kaolinite or carbonate. The favored mechanism for carbonate formation is hydrothermal or serpentinization reactions involving circulating waters at elevated temperature through ultramafic rocks in the subsurface. There is evidence for low-temperature metamorphic or hydrothermal alteration based on the presence of prehnite, which has specific formation conditions. The prehnite could not have formed in contact with the CO2 atmosphere and a mechanism whereby impacts excavate the prehnite material is favored. Hydrothermal systems resulting from impacts can be sustained for 1000 years or more depending on the size of the impact. The observations are indicative of alteration products that are usually formed in neutral to alkaline, rather than acidic, conditions.

Questions:
- Since the partial pressure of CO2 on Mars today is low (~0.006 bar) and the pressure is within the range of the conditions stated on p. 27, could it be possible that the prehnite did form in contact with an atmosphere that is similar to today’s atmosphere?
- If the prehnite did form at some depth, does that mean that the erosion rate has been very low since the Noachian and what implications does that have for the nature of the atmosphere?
- How can we relate this activity to the formation of the valley networks and the fact that alteration minerals are scarce in these regions?