Geologic Features on Mars

A) Examine Figure 1: Olympus Mons is a shield volcano 600 km in diameter, towering 25 km above the surrounding plain. Around its base is a steep cliff as high as 6 km. It has a summit caldera some 80 km wide.

1) Do you think the surface of Olympus Mons is geologically old or young, compared to the surface of the Moon? Explain your answer.

2) Why do think Olympus, and all the other volcanoes in the Tharsis region for that matter, were able to tower up to such high altitudes compared to similar structures on Earth?

3) Examine Figures 2 & 3: Figure 2 is a high resolution image of the caldera complex of Olympus Mons. Figure 3 is a generated DTM (Digital Terrain Model) of the same structure. Can you guess how many caldera structures are there? Can you infer the order of their formation?

B) Examine Figure 4: Apollinaris Patera and surrounding region. Several geologic processes can act to shape a planetary landscape.

4) What process do you think formed Apollinaris Patera, marked A? How can you tell?

5) Ma'adim Vallis is the channel in the southeast part of the photograph, marked D. What processes do you think formed Ma'adim Vallis? Justify your answer.

6) Consider the relationship between Ma'adim Vallis and Gusev, the 160 km diameter crater marked C. What could be the origin of the material that comprises the floor of Gusev? (Hint: the region slopes to the north.)

7) Based on your observations, and careful analysis if the higher resolution images in Figures 4a, and 4b, what is the probable order of occurrence of A, B, C, and D in Figure 4 (i.e., which came first, second, third, last)? Give evidence for your answer.

A Gamma-Ray Spectrometer, or (GRS), is an instrument for measuring the distribution of the intensity of gamma radiation versus the energy of each photon. Since every element has a distinctive signature; a "finger-print" energy by which it emits a gamma ray photon, this energy can be used to detect a certain element. In addition, the amplitude of the signal (related to number of photons observed for a certain energy), gives some information on the quantitative abundance of emitter element. The Gamma Ray Spectrometer (GRS) on board the 2001 Mars Odyssey has measured the elemental abundance of H, Si, Cl, K, Fe, and Th for the whole surface of Mars. Below, you'll see a table of these results averaged for the Tharsis region (only for Si, Fe, and K):

Element	Averaged wt %
Si	19.60
Fe	12.98
K	0.16

8) Now, knowing that these elemental abundances are expressed as weight percentage in relation to the complete spectrum (from Hydrogen to Uranium), can you infer how these abundances would be translated into their respective oxides?

Hints: Si is tetravalent, K is monovalent, and Fe is divalent. These elements have a.m.u. of 28, 39, and 56 respectively. In addition to Oxygen which is divalent with a.m.u. of 16

9) Now put those also into a TAS diagram (silica and alkalis), assuming a global average of Na_2O of 0.1. What do you get?

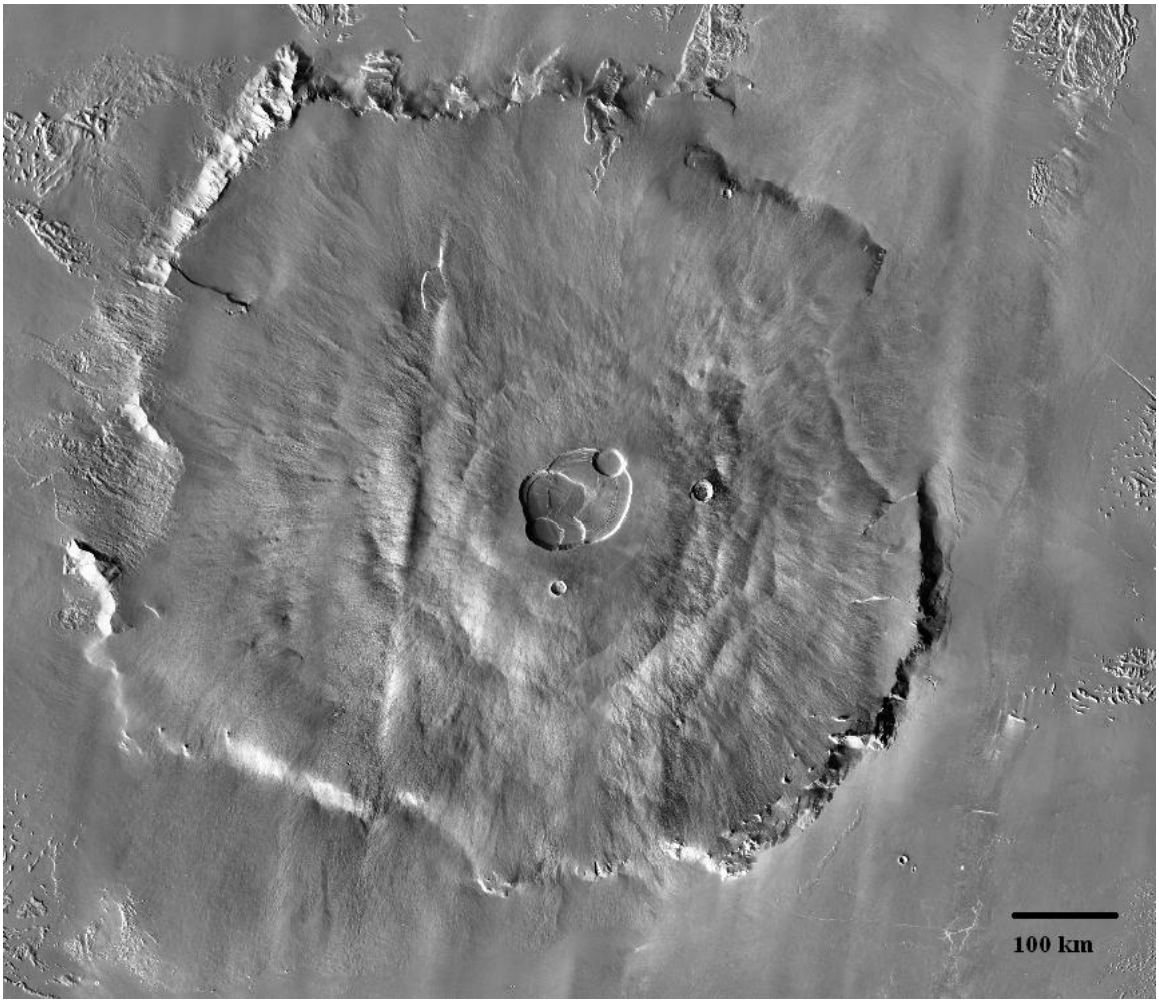

Figure 1. High resolution image of Olympus Mons.

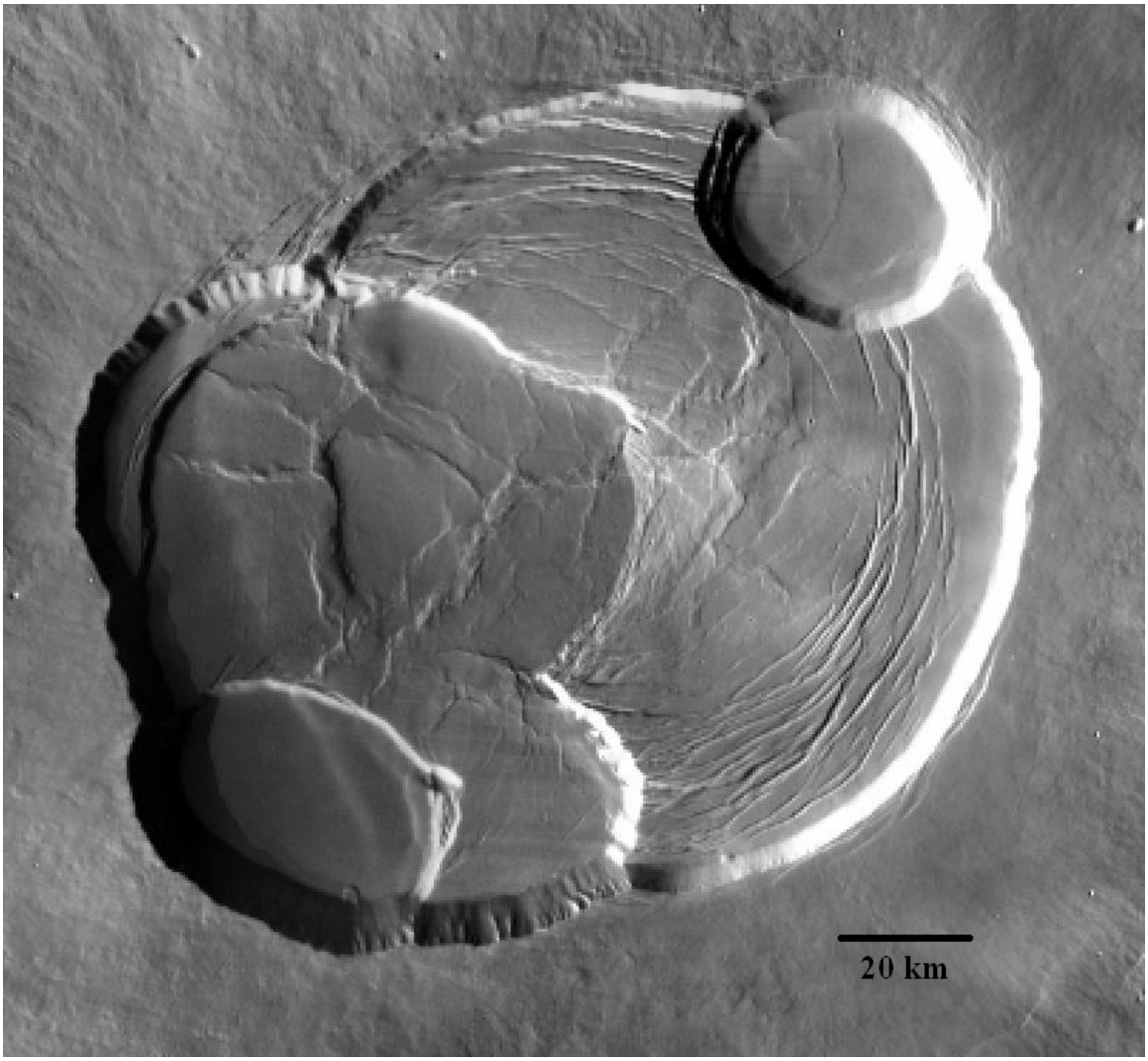

Figure 2. Olympus Mons Caldera complex

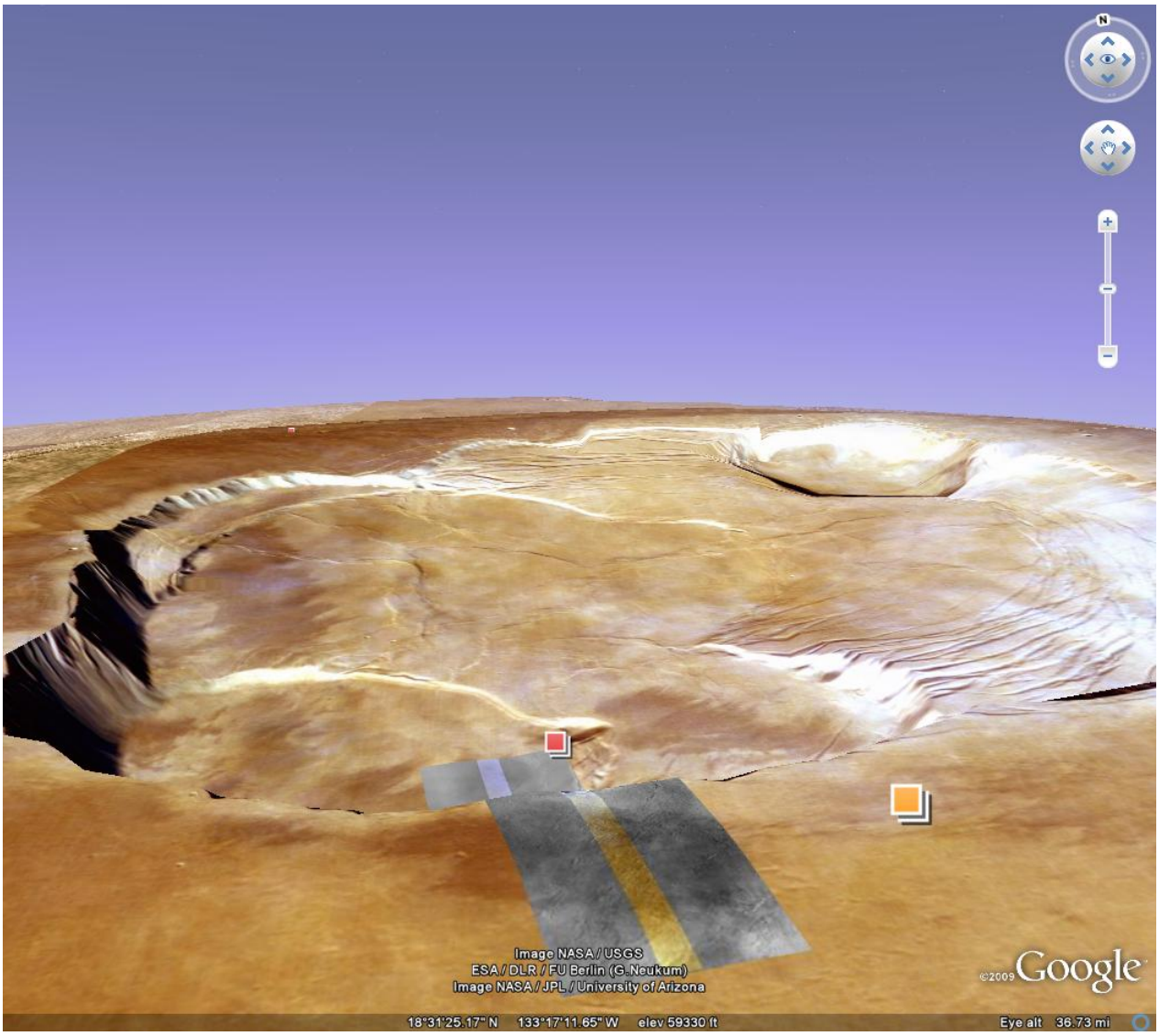

Figure 3. DTM of the Olympus caldera complex with a vertical exaggeration of 2.

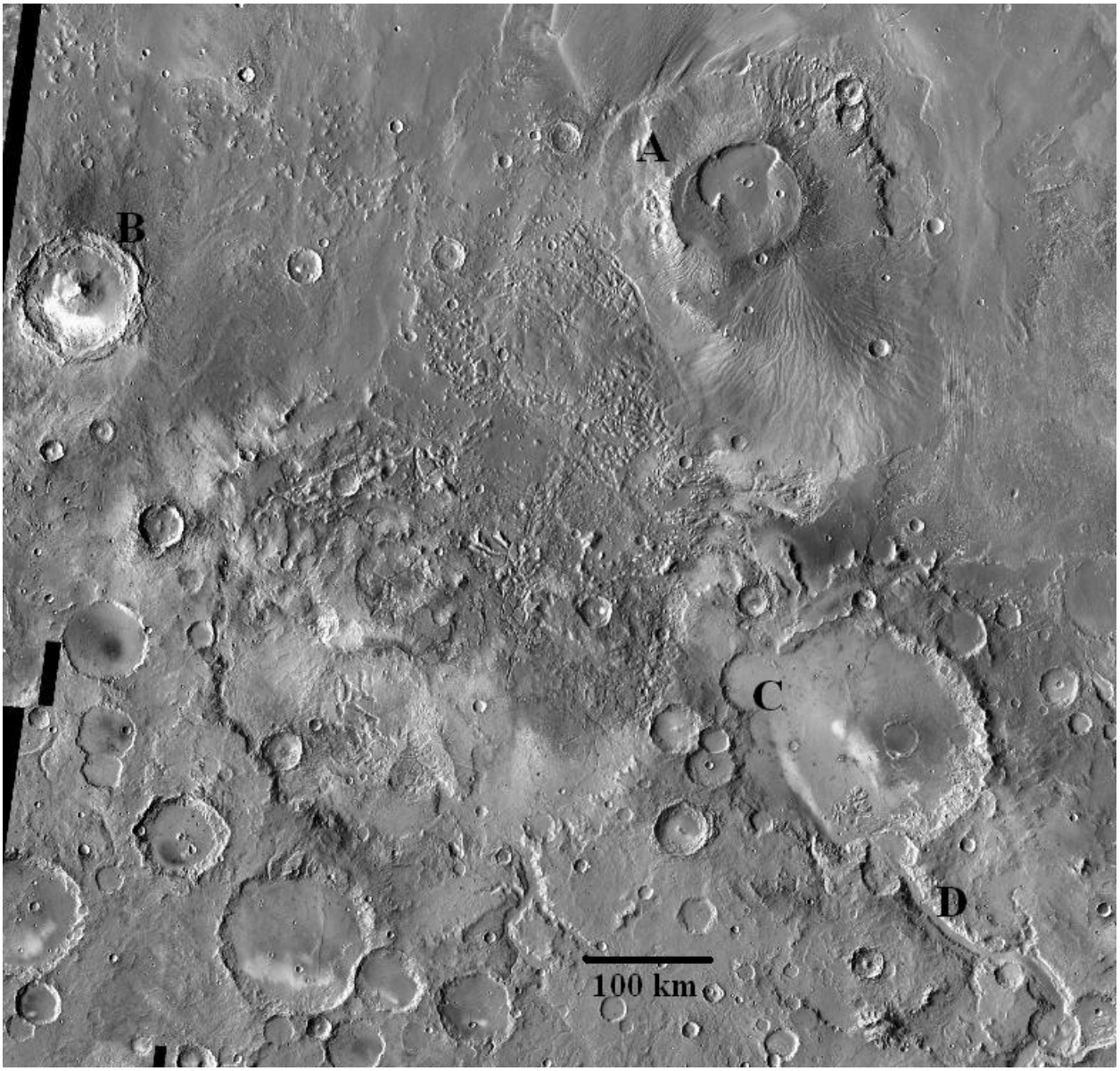

Figure 4. Apollinaris Patera and surrounding region centered at 10° S, 170° E.

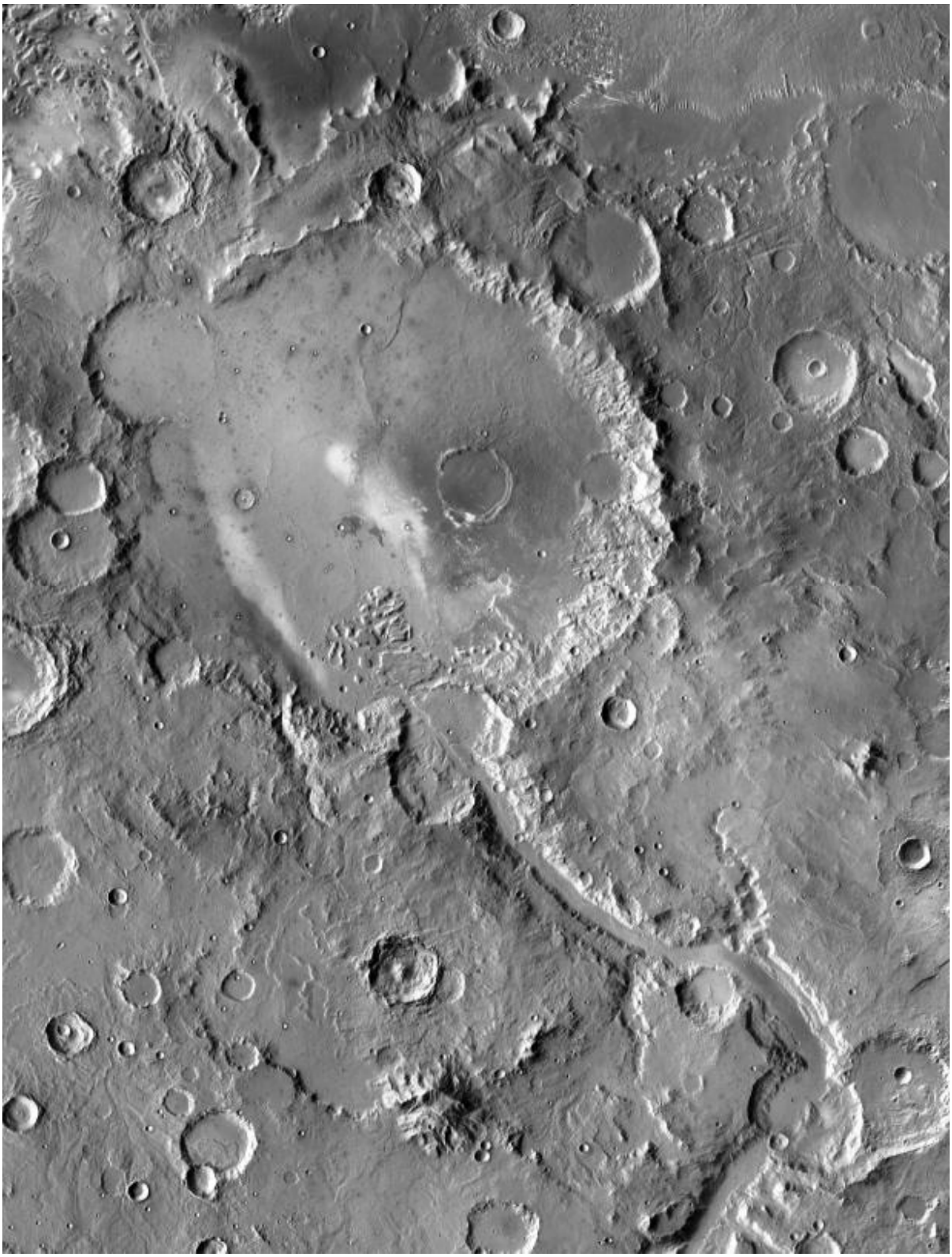

Figure 4a. Gusev Crater along with Ma’adim Vallis. Gusev crater is 160 km in diameter

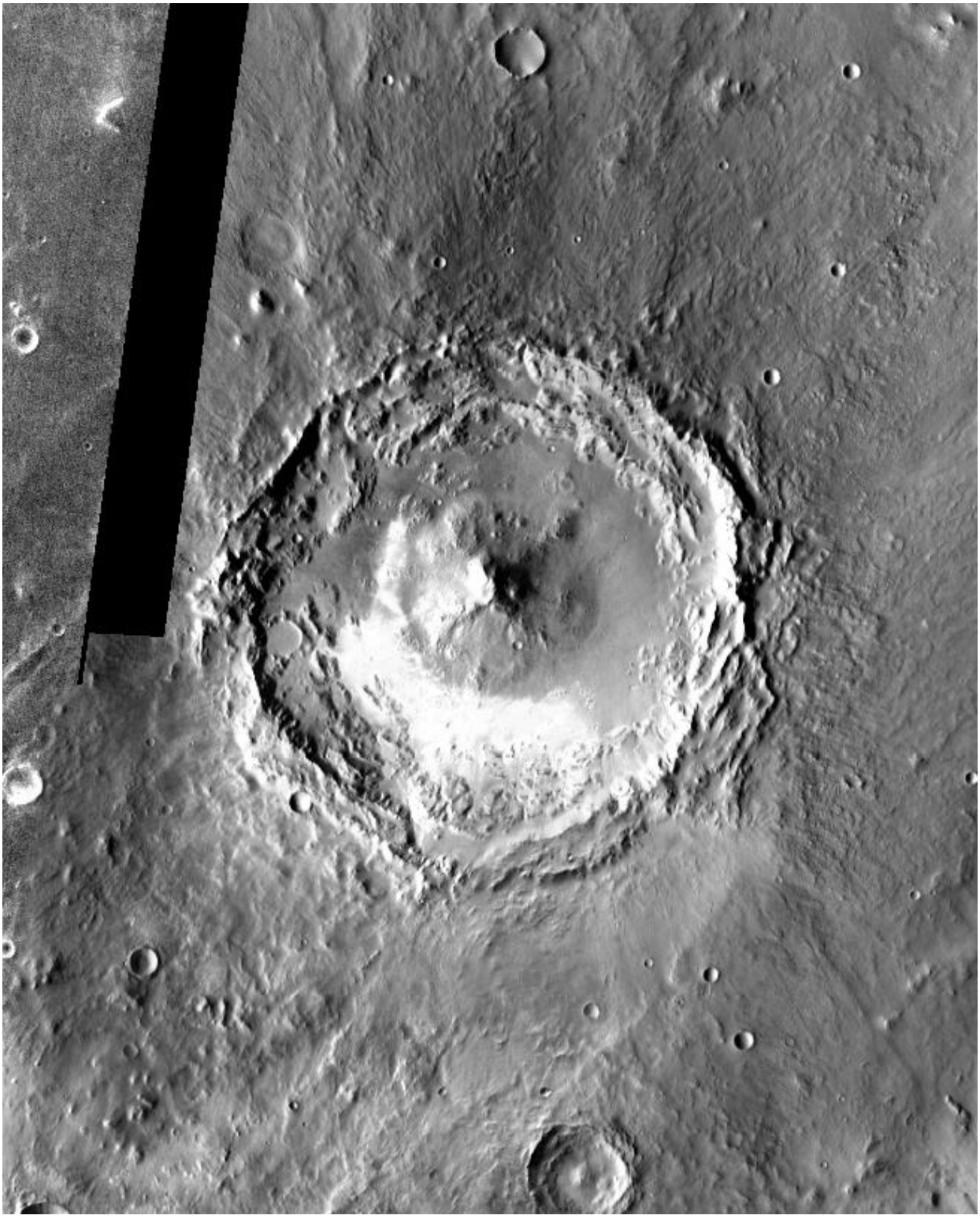

Figure 4b. Reuyl Crater