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The north polar cap, Mars: analysis of the surface topography

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The permanent polar caps of Mars constitute the largest known reservoirs of H_2O on the planet. They consist of layers of H_2O, dust and CO_2 that have been deposited through millions of years. The present extent, volume and surface morphology of the caps are results of geologic and climatic processes that have been shaping the caps over time.

The north polar cap was mapped with the Mars Orbiter Laser Altimeter (MOLA) topographic data. A characteristic feature of the cap is a spiraling pattern of troughs organized around the pole. Horizontal or north-facing areas appear white, while the steeper, south-facing slopes expose dark layers. The alternating bright polar ice and dark layers suggest that the cap interact with the atmosphere through deposition and sublimation processes. The spiraling pattern is thought to be formed by surface processes in a combination of sublimation, wind effects, deposition and ice flow. The north polar cap has several large reentrants. The largest is Chasma Boreale, which almost bisects the cap and separates a large ridge from the central part of the cap. Previous works suggested that Chasma Boreale formed by outflow of basal meltwater, but it was unresolved how water could form and collect beneath the cap.

The MOLA topographic data from the north polar cap has been analyzed in order to distinguish between surface and basal processes and to search for evidence of basal topographic structures. A combination of mapping, statistical data analysis and ice flow modelling was used. The analysis reveals two circular structures with diameters of several hundreds km, located near the head of the reentrant valleys. The characteristics suggest that they are evidence of impact craters. It is discussed how the suggested basal impact craters could provide the sub-cap water reservoirs needed for the outflow hypothesis.