SCALLOPED DEPRESSIONS IN MALEA PLANUM, SOUTHERN HELLAS BASIN, MARS. M. Zanetti[1], H. Hiesinger[1], D. Reiss[1], E. Hauber[2], G. Neukum[3]. [1]Institute für Planetologie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany. [2]Institute of Planetary Research, German Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin, Germany. [3]Freie Universität Berlin, Maltesertr. 74-100, 12249 Berlin, Germany. ZanettiM@uni-muenster.de

Introduction: In order to investigate the effect of climate change on the surface morphology of Mars, we produced a detailed map of the location of scalloped shaped depressions, a type of dissected mantle terrain [1], located on the southern wall of the Hellas Basin between 50°E to 70°E longitude and 50°S to 70°S latitude. This is the area of Malea Planum that contains Amphitrites and Peneus Paterae. The region is covered by a latitude-dependent, several meters thick, surface mantle [2]. The mantle is presumably composed of dust and water ice thought to be related to obliquity-driven ice activity as recently as 2.1-0.4 Myr [3]. It has been suggested that scallops are formed by interstitial ice subliming from pore spaces in the mantle material [1, 4]. Scallops display north-south asymmetries with steep pole-facing scarps and gentler equator-facing slopes [5, 6]. We studied these features in this area to determine the recent geologic evolution of the region and to study if the regional climate of the Hellas basin has had an impact on the formation of these scallops. We also surveyed the southern hemisphere to determine the extent of these features for any longitudinal dependency.

Data and Methods: Images from the High Resolution Stereo Camera (HRSC) on board ESA's Mars Express mission were used to map scallop shaped depressions in the region. MOC-NA and THEMIS-VIS were used to supplement the mapping. MOLA data allowed depth measurements and cross sections of individual scallops. HiRise images were used to investigate scallops and characterize them to the limit of resolution. TES data supplied seasonal temperature variation measurements. THEMIS-IR daytime images were used to determine temperature gradients within scallops.

Map of Scallops on the Southern Rim of Hellas: Scallops were observed in the study region almost exclusively between latitudes 52°S and 59°S. Fig. 1 shows our map of scallops. The light blue regions are where individual scallops or chains of scallops could clearly be defined and outlined. It can be seen that they contour the southern rim of the Hellas Basin. The areas where the scallops are most extensive and where we could measure their depths are along the highest topography of the rim between 1000 and -500 m altitude across our entire longitude range. Scallops then become smaller and shallower towards the basin center and are rare below -2000m. Scallops believed to be associated with the ejecta blanket of a large crater centered at 54.5°S, 65.6°E are responsible for the portion of the map found between -2500m and -4500m. No features interpreted as scallops were found in the region below -4500m. South of ~58°S scallops degrade quickly and are believed to have coalesced and eroded through the mantling material to an older layer. This is represented by the shaded green regions of the map south of the clearly defined scallops. Using MOLA shots, depths of individual scallops were measured and range between ~5m and ~40m. A radial pattern in the formation of scallops can be seen north of Peneus Patera, and scallops are often associated with the mantled ejecta blankets of craters in the region.

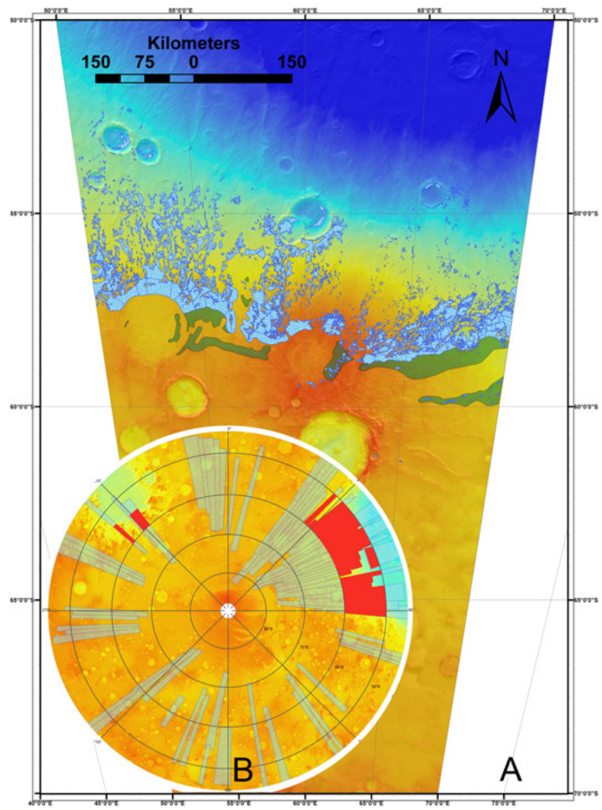

Figure 1. (A) MOLA map with mapped scallops shown in blue. Degraded scallops shown in green shaded areas. Inset (B) shows results from a southern hemisphere survey of scallops. Shaded blue areas are HRSC footprints, red areas denote where scallops were found. 0° meridian is at the top of the image, Argyre is to the left, Hellas is to the right.

HRSC South Pole Survey: The southern hemisphere of Mars was surveyed using HRSC images as a follow-up investigation to that done by Milliken [1] using MOC images. This was done to investigate whether there is a longitudinal dependence or effects of different geologic units or topography in the distribution of scallops at ~55°S Our survey revealed that scallops are found almost exclusively in the area along the southern slope of the Hellas Basin (30°E - 110°E), with very few isolated scallops occurring in the southern latitudes near Argyre Basin (300°E - 335°E). The inset in Fig. 1 shows the HRSC footprints inspected in blue and areas where scallops were found in red. The results of this survey point toward an effect of basin morphology on scallop formation and mantle deposition.

HiRise image interpretation: Small scale scallop formation can be interpreted using HiRise images. Fig. 2 shows what we interpret to be scallop evolution. Scallops begin at cracks in the mantle, and then grow into depressions by solar radiation insolation sublimation of interstital ice (Fig 2, #1). As the depressions grow, they take on their asymmetrical shape (Fig 2, #2). As the scallop evolves further, a characteristic scarp develops at the equator ward side (Fig 2, #3). As the scallop evolves further, they can coalesce and form large groups and chains as has been suggested previously [e.g., 5, 6].

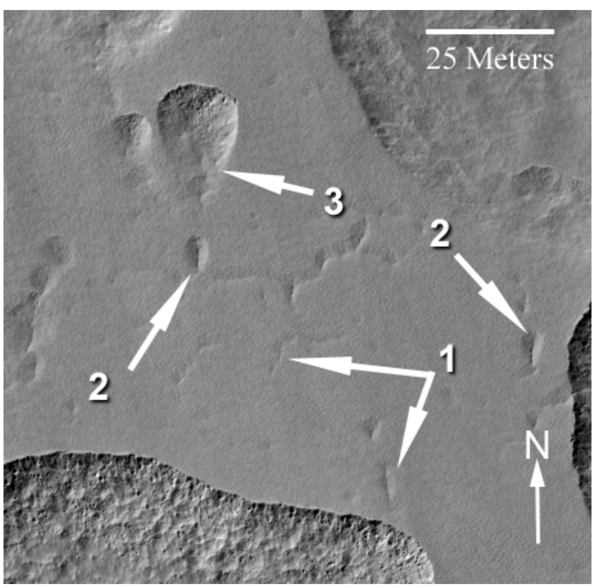

Fig. 2: HiRise image of scallops north of Peneus Patera. The image shows an interpreted evolution of scallops as described in the text (HiRise: PSP_005342_1225_RED).

Availability and Sublimation of Ice: Ice is stable in the subsurface of Mars and numerous researchers have modeled the stability of ice with latitude [e.g., 7]. On the southern slope of Hellas, ice has been modeled to be stable (or is theoretically stable) in the subsurface at a depth between 0.010m near 65°S and 1m the deep basin >50°S [7]. In the area that we mapped scallops ice is available within 10 cm of the surface. Sublimation occurs for water ice in appreciable amounts above 250K which would imply a season of sublimation in this region between Ls=200° and 350°, or early spring through late summer under present climate conditions. Based on TES data temperatures in areas covered by the most scallops approach or exceed 290K in the summer. Summer temperatures above 273K can occur between Ls=245°-315°. These temperatures would suggest that sublimation is physically possible and ongoing even when covered by an insulating dust layer [8]. THEMIS-IR images show a ~2-5K temperature difference between the pole-facing slope (colder) and equator-facing slope (warmer) of scallops. This supports the solar insolation model of Morgenstern [5] to explain the N-S asymmetry of the scallops, but introduces the need to remove any lag deposit that will suppress sublimation of interstitial ice. The removal of dust is important for sublimation to continue at deeper levels in the surface mantle because dust cover or overburden will act as an insulating layer on top of an ice layer [8, 9]. A mechanism for dust removal was not incorporated into the Morgenstern model for the formation of scallops [e.g., 5].

Wind on the Slopes of Hellas: While solar radiation insolation is the driving force for sublimation of ice from the mantle [5], wind, surface roughness, and turbulence all play an important role in the rates of sublimation [10]. Winds in the Hellas Basin have been modeled by Siili et al. [11], and during the time of sublimation, are found to be diurnally variable with weak upslope winds during the day and stronger downslope winds at night. Daily wind speeds are not sufficient to produce lifting of dust, but nighttime katabatic winds approach the lifting threshold at around 30m/s [11, 12]. We propose that weak daytime winds moving over the surface might enhance sublimation, and strong nighttime winds might be sufficient to entrain dust and remove it.

Outlook: We are currently working to model the rate of sublimation of ice from the mantle in this area to determine the formation and evolution of these features as well as the emplacement/removal of dust in the region.

References: [1] Milliken, R.E. and Mustard J.F. (2003), *Sixth International Conference on Mars*, *Abs. #3240.* [2] Kreslavsky M.A. and Head J.W. III (2002) *GRL, 29, No. 15, 1719* [3] Head et al. (2003), *Nature, 426, 797-802* [4] Plescia J.B (2003) *LPSC XXXIV, Abs. #1478.* [5] Morgenstern et al. (2007) *JGR 112, E6*. [6] Lefort et al. (2007), *LPSC XXXVIII Abs. #1796* [7] Mellon et al. (2004), *Icarus, 169, 324-340* [8] Chevrier et al. (2007), *GRL 34, L02203* [9] Schorghofer and Aharonson (2005), *JGR 110, E05003* [10] Taylor et al. (2005), *Icarus 181, 2* [11] Siili et al. (1999), *P&SS 47, 951-970* [12] White et al. (1997), *JGR 102, E11*