LANDSLIDES AND THE TECTONIC SCARP IN COPRATES CHASMA – EXAMPLES STUDIED FROM HRSC DATA. K. Luiro[1], J. Raitala[1], E. Hauber[2], G. Neukum[3] and the HRSC Co-Investigator Science Team. [1]Astronomy, Department of Physical Sciences, University of Oulu, PO BOX 3000, FIN-90014, Finland, kluiro@paju.oulu.fi; [2]Institute of Planetary Research, DLR, Berlin, Germany; [3]Institute of Geosciences, Department of Earth Sciences, Freie Universitaet Berlin, Germany.

Introduction: Coprates Chasma forms the eastern part of the Valles Marineris main trough. A striking feature of Coprates is the linear scarp at the floor joint, cutting spur and gully systems on the wall, thus leaving triangular facets. This scarp, especially prominent on the northern wall of Coprates Chasma, can be categorized as a tectonic faulting feature [1]. While the scarp is mostly intact throughout the Coprates system, major landslides stretching across the canyon floor were already found from VIKING images [2]. We looked at the new MEX-HRSC data to see evidence for smaller mass wasting events, too, in the 1 km range that would overlap the tectonic scarp. Hence, we would arrange a three level age estimation: events predating the scarp, events associated or contemporating with the scarp, and events postdating the scarp. Furthermore, the presence of a fan-shaped apron would indicate the landslide to be younger in age or more resistant to fluvial or aeolian erosional processes that took place on the canyon floor.

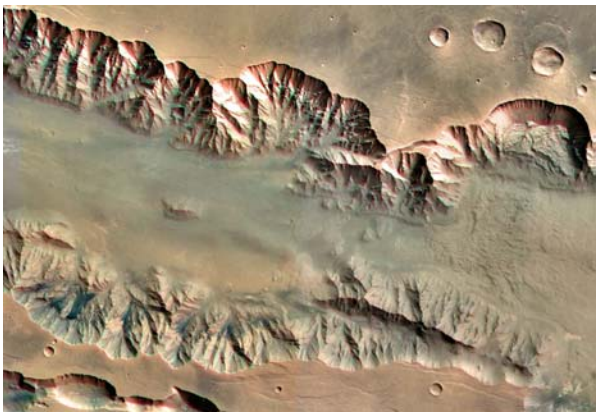

Figure 1. A wall collapse and other smaller scarp deformations in central Coprates Chasma in a colored mosaic.

Earlier data and HRSC Images: Massive landslides in Valles Marineris were found from Viking images [2]. Two such events, visible in HRSC at 292°E and 296°E in Coprates Chasma (*Fig. 1*), cut the north wall tens of km wide and distributed material across the canyon floor. These events carved deep arcuate re-entrants to the Coprates north wall thus postdating the scarp. With HRSC nadir images, details well below 100 m are observed while maintaining a good context, thus revealing many smaller mass wasting events, and providing a relevant dataset for studying both large and small-scale mass wasting events and for assessing the post tectonic activity.

Events classified: The landslides observed were classified by their suggested type and visual shape.

The types are: DR = Dry rock avalanche; *DR*+ = As previous, but a flat distribution of landslide debris rather than thick, perhaps due to weaker or finer source material; *LD* = Long debris flow, no apron or it has been eroded; *LDF* = As *LD*, but greater volumes or harder materials have sustained the aprons; *COL* = Wall collapse, possibly much deeper rocks exposed than on any of the previous types, and large volumes of chaotic material still visible on canyon floor.

The landslide shapes can be elevated (e.g. cone as in *Fig. 2*) or flat, thin or thick (weak or prominent flow), a v-shape cut through the scarp or a continuation of an upper gully, and with or without a debris apron at the bottom (fan shaped flat, wall collapse chaotic zone)

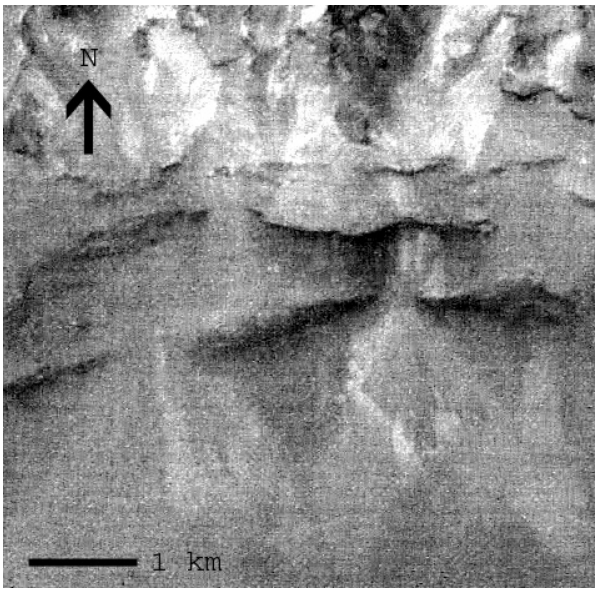

Figure 2. Terraced scarp and dry rock avalanches (*DR*).

Image resolution: The resolution in the images used varies from 12 to 65 m/pixel. The earlier HRSC orbits have a finer resolution, although various conditions (illumination, possible haze in valleys, map projection) affect the practical use a lot.

An event in detail: Fig. 3 shows a small landslide with a clear fan-shaped apron. The arrows mark the alcoves that do not fit the surrounding spur-gully morphology, thus proposing areas where wall rock met the conditions for collapse [3]. A facet much higher than others cuts the spur above. As often in Coprates, the upper wall gullies stretch way down, and material contribution from upper wall rock is implied, although it may have happened during an extended period after the fan-producing slide. A small crater decorates the apron, but the possibility to involve this event to nearby crater density countings and thus absolute age estimation [1] is unsettled.

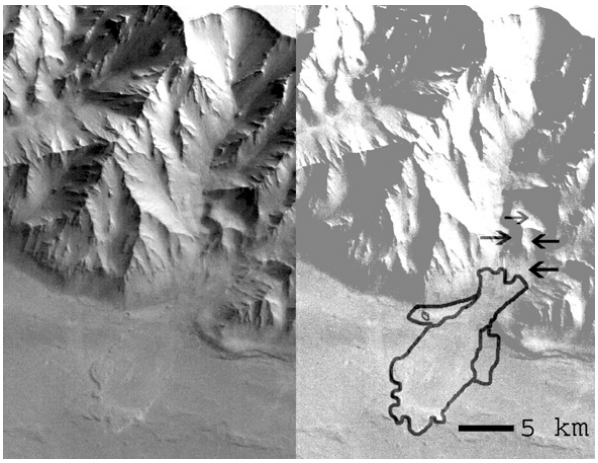

Figure 3. A landslide with a fan in Orbit 471.

Results: From the six HRSC datasets studied (orbits 100, 165, 438, 449, 471, 515), all show marks of mass wasting overlapping the tectonic scarp. The size of the events varies greatly: massive collapses are visible in Orbit 515 covering the western Coprates and in Orbit 438 over the central Coprates, while most of the 28 events detected and classified are just 1 to 5 km wide. Only two smaller events in Orbits 438 and 471 show a clear fan-shaped apron. The mixed floor surface as viewed in Orbit 515 (*Fig. 4*) shows various grabens on the floor and a crater: hence the landslide flowed upon the scarp and the grabens, but was later deformed due to an impact.

The general lack of aprons favors such ideas that erosional processes have cleaned the canyon floor from loose materials, while also the lack of coarse material or boulders in the landslides studied makes the aprons smooth and erodable. Most small landslides are made of fine material, perhaps of wallrocks already affected by aeolian erosion, that spreads thin and even. The two major collapses studied overlap the tectonic scarp and show massive slices of wall material resistant to the erosion – due their size and perhaps a deeper wall rock type – that has consumed most of the smaller aprons.

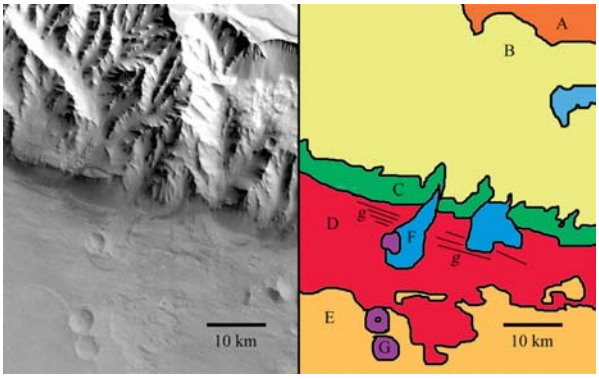

Figure 4. Aprons, impact craters, erosion and graben mixed as viewed from orbit 515 nadir (left). The proposed morphological and geological sketch (right) identifies: A = upper (pre-Valles) plateu, B = wall rocks on spur and gully systems, C = wall rocks on scarp (younger than B), D = lowest floor level (old plateu descend?), E = second floor level (more resistant to erosion), F = landslide deposits, G = impact craters and g = graben.

Conclusions: Landslide studies provide a view to erosional events which have taken place in Coprates Chasma after the last tectonic step – the formation of the north wall scarp. From HRSC images plenty of mass wasting events postdating the scarp are observed – according to *Schultz* [3] these events could be triggered by seismic activity in the trough-bounding faults, and thus these events would be associated with the crustal stress in Valles Marineris area. Further erosional processes affecting the wasted material are evident – only a few aprons are seen in addition to the two massive wall collapses.

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References: [1] Lucchitta B.K. et al. (1992) "*Mars*" (H.H. Kieffer et al.), pp. 484;490-491. [2] Carr M. H. et al. (1984) *"The Geology of the Terrestrial Planets"* NASA SP-469 pp. 248. [3] Schultz R.A. (2002) *"Stability of rock slopes in Valles Marineris, Mars"* Geophysical Research Letters 29(19), 1932, doi: 10.1029/2002GL015728, 2002.