NEW INSIGHTS INTO THE HYDROLOGY OF THE SHALBATANA OUTFLOW CHANNEL, MARS: TERMINAL IMPOUNDMENT AND INTRAVALLEY LACUSTRINE ACTIVITY. G. Di Achille[1], G. G. Ori[1], D. Reiss[2], [1]International Research School of Planetary Sciences, Pescara, Italy, [2]Institute of Planetary Research, DLR, Berlin, Germany.

Introduction: This study reports about an undescribed intravalley paleolake detected along the course of Shalbatana Vallis (**L** in Fig. 1a-b-c) from the evidence of shorelines and the occurrence of a few fan-delta deposits (including a Gilbert-type delta). We focus on the sedimentological investigation of the sedimentary deposits whose analysis lead us to the paleohydrological reconstruction of the lacustrine system [1]. Our hydrological analysis and crater counting results provide new insights into the latest activity of the Shalbatana outflow channel suggesting that the valley was impounded during its final hydrological activity (Late Hesperian) and that ponding of water lasted enough time to allow the formation and evolution of the lacustrine system.

Geomorphology: The study area is located at about 250 km downstream of the chaotic crater interpreted as the latest source region for the Shalbatana discharges [2] (**C** in Fig. 1a). At this location the valley's width ranges from 11 km to 18 km, whereas the maximum depth is about 2500 m with respect to the plateaus. Here is located the approximate centre of a local topographic low delimited by the -2800 m MOLA contour (**L** in Fig. 1a-b-c). Most of the channel walls display extensive evidence of mass-wasting processes and the rare small impact craters on the resulting deposits suggest a relatively recent formation for them. Several landslides are also visible along the valley walls and some of them were likely initiated by impact craters (Fig. 1b). In the northern part of the study area a quite large (10 km long by 17 km wide) rotational slump formed on the eastern wall of the channel (Fig. 1b). This entirely overlaps the valley floor rising up to the opposite channel wall and also interrupts the -2600 m topographic contour (Fig. 2a) separating the channel into two isolated sectors up- and down-stream of it, respectively.

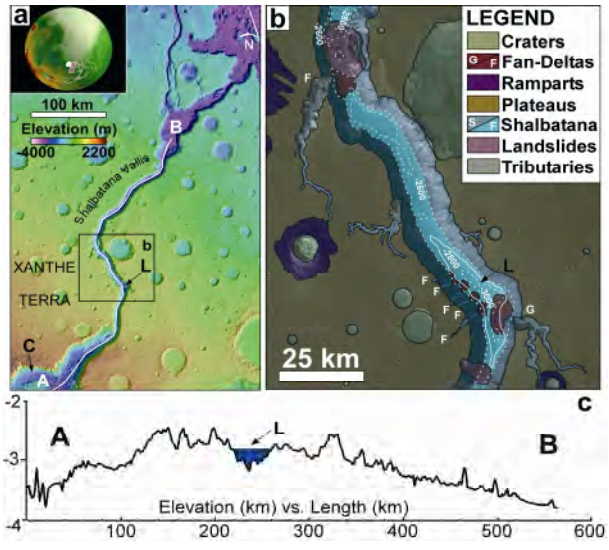

Figure 1. *(a) Location map of the study area.* ***L*** *indicates the location of the study lacustrine system;* ***C*** *a chaotic crater. (b) Geomorphological map of the study portion of the valley (****G*** *and* ***F*** *of the Fan-Deltas unit indicate Gilbert-type and indistinct fan-delta, respectively,* ***S*** *and* ***F*** *of the Shalbatana unit indicate valley slope and floor, respectively). Contours are from MOLA data (spacing 200 m). (c) Topographic profile* ***AB*** *of the Shalbatana Vallis floor from MOLA gridded data.*

Finally, the area contains 7 distributary fan-shaped deposits (Fig. 1b): the northernmost is overlapped by the above mentioned slide, whereas a series of other delta-like deposits are concentrated in the southern part in association with the intravalley depression encompassed by the -2800 m contour (Fig. 3). Additional small tributaries are also visible along the walls of the study portion of Shalbatana. They deposited alluvial material on the main channel floor and suggest that the fluvial activity of Shalbatana Vallis was gradually superseded (along with the valley drying) by groundwater seepage along its walls [3]. As a result the original shape of the valley's walls was modified and most of the former channel banks and fluvial deposits were covered.

Fan-deltas and shorelines: The southern group of deltaic deposits is comprised of a main delta along the right wall of the valley and a series of five opposite smaller fan-deltas, of which the bigger is located in front of the main deposit (Fig. 1b and 2). The deposits were fed by tributary channels of the main Shalbatana Vallis and lie on the floor of

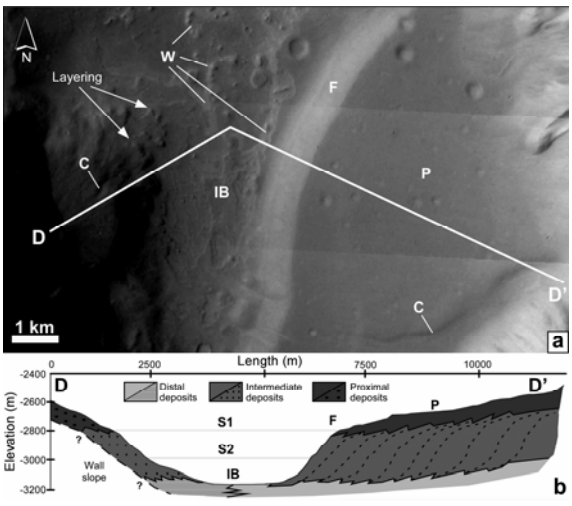

Figure 2 *(a) Themis Visible close up of the two opposite and bigger fan-deltas (****C*** *- latest distributary channels;* ***P*** *– delta-plain;* ***F*** *- delta-front;* ***IB*** *– possible interbedded sequences;* ***W*** *– thin white deposits); (b) Apex to apex topographic profile of the fan-deltas (see a for location) from HRSC stereo-derived DTM with sketch geologic section.*

the valley. The main delta has a maximum width of 12 km (with a main radius of 7 km), whereas the opposite and bigger of the additional fan-deltas is 3 km wide with a 2.5 km radius (Fig. 2). The major fan shows an almost flat delta-plain (**P** in Fig. 2) dissected by the latest active distributary channel (**C** in Fig. 2a), and a steep delta-front which declines into the Shalbatana valley floor (**F** in Fig. 2). Although the study delta is almost not eroded and shows well-preserved depositional morphology, at its northern toe, some erosional windows also reveal its internal structure with the sub-horizontal layering of the bottomsets sequences (Fig. 3a).

The bigger of the facing fan-deltas also shows evidence for distributary activity on its surface (**C** in Fig. 2a) and appears depleted of its fine superficial fractions, showing its internal layering (Fig. 2a). The five smaller fan-deltas range in radius from 1.5 km to 3 km (Fig. 3). The digital topography is not enough detailed to assess their morphometry; nevertheless, the examination of the shadow geometry from the visible imagery (HRSC and Themis) reveals that all the deposits present longitudinal slope breaks (Fig. 3c).

In addition to the above sedimentary deposits, it is also possible to identify terraces and at least two well-visible shorelines along the walls of the study portion of the valley (see **S1** and **S2** in Fig. 3b-c). In particular, S1 is the uppermost and the most continuous of two: the strandline coincides with the delta fronts of the two opposite fan-deltas marking the water level at -2800 m and also with the slope breaks along the five small fan-deltas (Fig. 3c). Finally, the deepest part of the local topographic low is characterized by the presence of thin white outcrops (see **W** in Fig. 2 and 3a) almost entirely encircled by the -3100 m contour. These white materials could represent the remnants of evaporitic deposits formed during the terminal declining and disappearance of a standing body of water.

Discussion and conclusion: Several lines of evidence support the presence of a paleolake along the course of Shalbatana Vallis: first of all the unusual presence of 6 fan-deltas whose fronts are aligned along the same topographic contour (at about -2800 m; Fig.3c), but also well-visible shorelines and possible evaporitic deposits on the deepest floor of the proposed paleolake (Fig. 2, 3a). Hydrogeological analysis of the system revealed that Shalbatana was impounded during its final activity and that the lake formed after the end of the last Shalbatana discharges. Crater counting and absolute age determinations indicate that the last activity within the narrow part of Shalbatana Vallis and the delta formation occurred around 3.5 – 3.4 Ga ago. These results translated into the Mars chronological reference imply that the intravalley lacustrine system formed as early as Late Hesperian [4]. Water source for the system is uncertain but a composite sapping mechanism with a dominant runoff component seems the most reasonable hypothesis. However, groundwater activity could have been also triggered/accelerated by local magmatic intrusion and impact craters. As a result, it is uncertain whether the hydrological activity was uniquely sustained by a favourable climatic regime and the possibility that the system evolved relatively independent from climatic conditions can not be discounted.

References: [1] Di Achille et al., *submitted* [2] Cabrol et al. (1997) *Icarus., 125(2)* [3] Kuzmin et al., (2002) *LPSC XXXIII*, #1806. [4] Hartmann and Neukum, (2001), *Space Sci. Rev., 96*, 165–194.

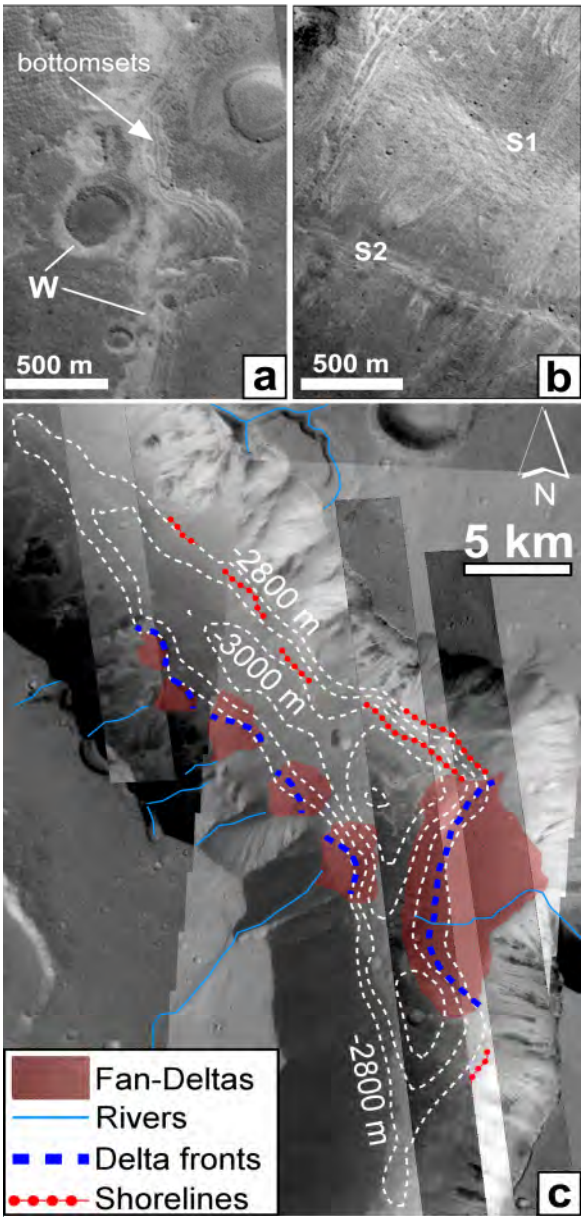

Figure 3. *(a) MOC close up of the main delta's internal structure (**W** – thin white deposits); (b) MOC view of the **S1** and **S2** shorelines along the Shalbatana Vallis wall; (c) the match between the topographic contours, delta fronts (blue dashed lines), and **S1** and **S2** shorelines (red dotted lines).*