

**GLOBAL MAPPING OF MARTIAN DELTA DEPOSITS.** B. De Toffoli<sup>1</sup>, A-C. Plesa<sup>1</sup>, E. Hauber<sup>1</sup> and D. Breuer<sup>1</sup>. <sup>1</sup> Institute for Planetary Research, DLR, Berlin, Germany (Barbara.Detoffoli@dlr.de)

**Introduction:** River deltas are landforms generated by deposition of water-carried sediments as the flow enters a slower-moving or stagnant water body. The presence of delta deposits on Mars has been thoroughly demonstrated for decades [1]. Large scale mapping [2,3] highlighted the presence of several delta fans mainly located on the dichotomy boundary. These features raised great interest due to their potential as indicators of water distribution and availability through time (e.g. the delta in Jezero crater was chosen as landing site for NASA's Perseverance rover mission [e.g. 4]). While a previous delta inventory was outlined by Morgan et al. [5], we aim to update and finalize a complete mapping of delta deposits in order to allow the examination of the evolution and distribution of standing bodies of water on Mars. The objective of our project focuses on the production of a global catalogue of water-related features at the Martian surface, which are commonly studied separately or at smaller scales.

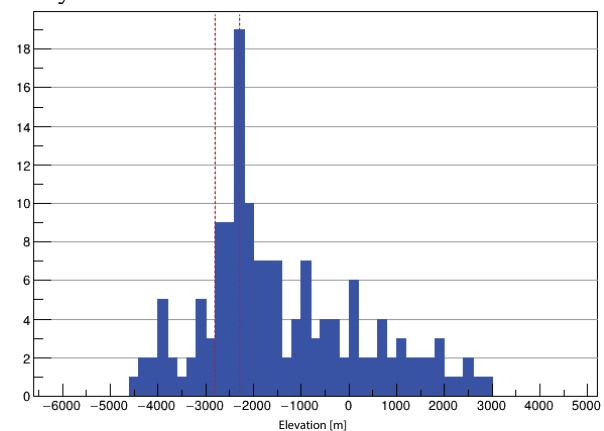
#### Methods:

**Mapping.** The CTX (6 m/px) global mosaic coupled with MOLA elevation information was used as base-map for the search for deltaic deposits at the global scale. Depositional features were interpreted as delta fans when all the following traits were displayed: (i) presence of a feeding channel, (ii) fan shaped deposit with a flat top, and (iii) distal margin outline characterized by the presence of a frontal scarp. Due to the strict relationship between delta deposits and feeding channels, we screened the whole highlands and dichotomy regions of Mars which are the areas with the highest channel density [6].

**Classification.** For each observed delta we collected (i) the location, (ii) a mean elevation value of the deposit's top, (iii) length and type of the feeding channel (the type categorization was based on the one used for the global channel mapping [6]), (iv) the type of basin where the delta sits (closed basin= crater with no outlet; open lake= crater with outlet; open basin= deltas not contained in local basin or deltas formed at the mouth of tributaries opening into outflow channels), and (v) the flow direction (derived by measuring the direction that connects the apex to the front of the delta).

We examined the observed features based on two main traits: length of the feeding channel and elevation at which each delta is located. Firstly we measured the length of the feeding channel since the length of the feeding valley may be (i) a proxy for the duration of the aqueous activity in the channel-delta system, and (ii) proportional to the age of the delta [3]. The latter

relationship links older deltas near Chryse Planitia (>3 Ga) to longer valleys, while younger deltas are usually fed by shorter valleys [3]. Secondly, we measured the elevation of the delta population (Fig.1) and compared the obtained dataset with the hypothesized sea level elevation of  $-2540 \pm 177$  m firstly suggested by Di Achille and Hynek [2] for a northern ocean through the analysis of deltas.

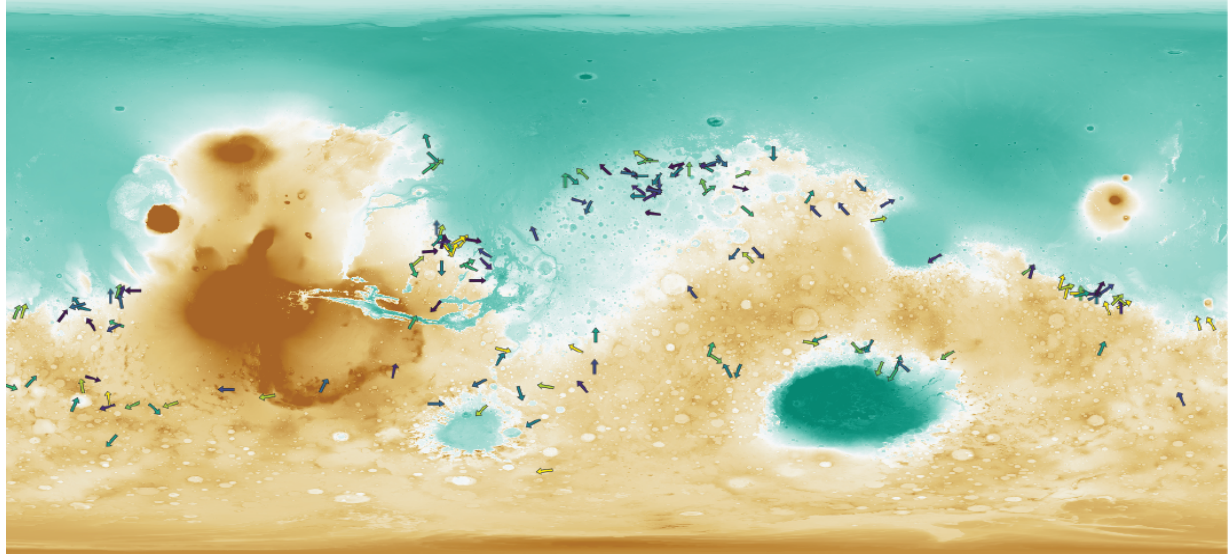


**Fig.1:** The abundance of deltas (y axis) versus the mean elevation of the top of the delta deposit (x axis). Red dashed lines represent the elevation range of the suggested sea level [2].

**Results:** Globally, we observed 151 deltas (Fig. 2) among which many were not previously included in published literature [e.g. 2,3,7].

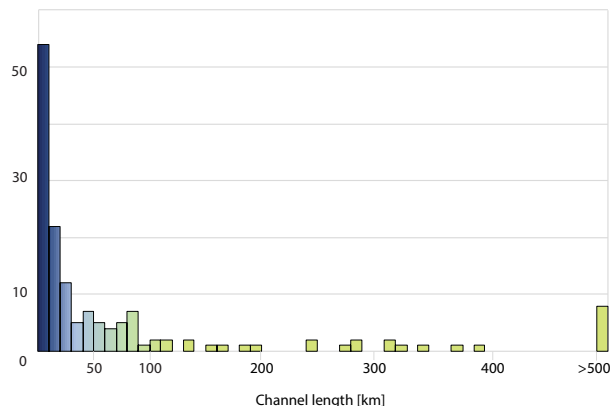
**Length of feeding channels.** The majority of the global delta population was fed by channels below 100 km in length, with a clear notable abundance of channels below 30 km (Fig. 3) which were barely mapped in the global channel database that had its minimum cutoff at ~20 km [6].

**Elevation.** We find that only 19 out of 151 of the observed deltas strictly fit into the sea level elevation range of [2], among which 11 are fed by short channels (<30 km). Differently, 25 out of 151 deltas are located below this level and 15 of those are fed by short channels. Among these, only 2 deposits fall into an ancient lower shoreline recently suggested to be located between -3795 m and -3442 m [8]. The remaining 107 deltas are situated above the hypothesized sea level [2] and 61 of them are fed by short channels. On the other hand, most of the deposits linked to the longest channels (>500 km; max= ~7158 km) are also contained within



**Fig. 2:** Deltas are represented on a colorized elevation MOLA map. Each delta is represented by an arrow pointing at the flow direction and colored on a scale from blue to yellow to indicate a progressively increasing length of the feeding channel.

this group. Additionally, this portion of the population displays a large span of elevation values ranging from a minimum of -2214 m to a maximum of 1360 m (mean = -1372 m).



**Fig.3:** Abundance of deltas (y axis) versus the length of feeding channel (x axis).

**Preliminary Discussions:** This global overview on the delta deposits present on Mars highlights several critical aspects that need to be considered in order to draw further conclusion concerning water availability throughout the Martian history. In fact, if the relationship between feeding channel length and delta age found for a sub-group of the population [3] is applicable as a rule of thumb to all deltas, many of the deposits have the potential to be Hesperian or Amazonian in age. They would thus be younger than the ocean that might have occupied the northern lowlands during the Noachian-Hesperian boundary period [2] and thus be unrelated to a global sea level range. In fact, less

than half of the delta population is related to medium/long feeding channels (>30 km). Abundant pristine morphologies, both related to the feeding channels and the deltas, also supports the hypothesis that part of the population is younger than Noachian. Additionally, the large variety of elevations where the deltaic deposits can be found and the very small amount of deltas included in the sea level elevation range proposed by Di Achille and Hynek [2] raise questions about the generation and environmental implications of these features, especially when seen at global scale. Therefore a closer look will be taken into the 2D and 3D geomorphological traits and age determination for each delta. On a larger scale, their distribution will be investigated to obtain insights into the related water availability and distribution at the surface through time which might also be linked to thermal and topographical configurations different to the present-day ones [9,10].

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**References:** [1] Nazari-Sharabian, et al., *Galaxies* 8 (2020). [2] Di Achille, G. & Hynek, B. M., *Nat. Geosci.* 3, 459–463 (2010). [3] Hauber, E. et al., *J. Geophys. Res. E Planets* 118, 1529–1544 (2013). [4] Mangold, N. et al., *Astrobiology* 20, 994–1013 (2020). [5] Morgan, A. M., et al., *Lunar Planet. Sci. Conf.* (2018). [6] Alemanno, G. et al., *Earth Sp. Sci.* 5, 560–577 (2018). [7] Ori, G.G. et al., *J. Geophys. Res. E Planets* 105, 17629–17641 (2000). [8] Duran, S. et al., *Sci. Rep.* 9, 1–6 (2019). [9] Bouley, S. et al., *Nature* 531, 344–347 (2016). [10] Plesa, A.-C., et al., *EPSC2020-698*.