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► **To cite this version:**

Gwénaél Caravaca, Nicolas Mangold, V. Ansan, Gilles Dromart. Early Zanclean coarse-grained deltas of southern France as terrestrial analogs to jezero western delta. 56th Lunar and Planetary Science Conference, Lunar and Planetary Institute, Mar 2025, The Woodlands (Texas), United States. pp.1831. hal-04929245

HAL Id: hal-04929245

<https://hal.science/hal-04929245v1>

Submitted on 4 Feb 2025

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EARLY ZANCLEAN COARSE-GRAINED DELTAS OF SOUTHERN FRANCE AS TERRESTRIAL ANALOGS TO JEZERO WESTERN DELTA. G. Caravaca^{1,*}, N. Mangold², V. Ansan², G. Dromart³. ¹Géosciences Environnement Toulouse, CNRS, IRD, CNES, Univ. Toulouse, France; ²Laboratoire de Planétologie et Géosciences, CNRS, Nantes Univ., France; ³Laboratoire de Géologie de Lyon-Terre Planètes Environnement, ENS, Univ. Lyon, France. *gwenael.caravaca@univ-tlse3.fr

Introduction: Since its landing in February 2021 and until the end of 2024, the *Perseverance* rover of the Mars 2020 mission has acquired observations on the western sedimentary fan of Jezero crater. First remotely, and then *in-situ*, these data have been useful to confirm the formation of the fan as a Gilbert-type delta, fed by water inputs from Neretva Vallis [1-4]. While the extensive data acquired with the rover allows to finely study the facies and geometries of the delta, some questions could be solved with help from a more external point of view. In that, we here propose terrestrial analogs to the Jezero delta to observe and compare mechanisms that led to the morphologies now preserved on Mars. We focus our attention on coarse-grained, barely lithified Gilbert-delta systems from the Early Zanclean period (~5 Ma, Early Pliocene) in southern France that could offer such analogies.

Localization and geological context: The Messinian Salinity Crisis occurred ~5-6 Ma (Late Miocene) and led to a dramatic fall in Mediterranean Sea levels as its connection to North Atlantic was severed [5]. This event led to the formation of numerous coastal basins, such as in the Roussillon region of Southern France (Fig. 1) [6]. At the end of the crisis, at the beginning of the Zanclean (~5 Ma), the Roussillon basin was flooded again and became a ria [6]. However, higher erosional rates associated with fault activity increased the local sedimentary supply, leading to the formation of numerous Gilbert-deltas on each sides of the basin. Nowadays, remnants of this activity are visible onshore in the Têt and Tech valleys. In this work, we present data gathered during a field campaign in May 2023 on two deltaic outcrops (Fig. 1): a quarry in Ille-Sur-Tête area, designated in the French National Inventory of Natural Heritage (INPN, #LRO2097), and a Tech river section near Le Boulou.

We specifically chose these locations, because they share morphologies and (apparent) facies with two sites of interest in the Jezero crater with well-expressed deltaic features: Pinestand Mountain for its foresets [7] and Franklin Cliffs for its fluvial topsets [4].

Analogies observed: While both foresets and topsets were observed at each analog outcrop, we elected each outcrop for a specific set of morphologies

to be compared with Jezero outcrops. At Ille-Sur-Têt quarry, we focus on the sandstone-dominated foresets to compare those observed at Pinestand Mountain (Fig. 2). At Le Boulou section, we focus on the conglomeratic topsets to compare with those observed at Franklin Cliffs (Fig. 3). Both sections are composed of predominantly quartzo-feldspathic rocks, and, thus, cannot be compared to Jezero delta mafic composition. Yet, they have never been much buried, except by quaternary colluvium, and are poorly cemented, a characteristic that also applies to Jezero delta.

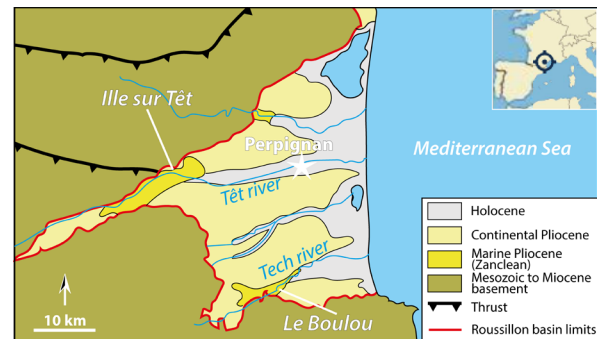


Fig. 1: Localization of the two analog outcrops in the Roussillon basin of southern France (simplified geological map after [6]).

Ille-Sur-Têt/Pinestand Mountain. Pinestand Mountain in Jezero is an outcrop on top of Jezero delta showing two large-scale sets of sigmoid, parallel beds mostly made of sandstones (with pebble conglomerate intervals) and identified as foresets (Fig. 2a) [7]. There, the topset part of the deltaic succession has not been preserved. At Ille-Sur-Têt, we observe a very similar succession, sharing a sandstone-dominated composition with locally coarser-grained intervals, steep dip angles (~30-40°) and the absence of topset beds (Fig. 2b). The main difference, except for the obvious bioturbation due to vegetal cover is the “hoodoo-like” erosional profile that is absent on Mars. This results from poorly lithified sediment being eroded away by meteoritical phenomena occurring on Earth.

Le Boulou/Franklin Cliffs. Franklin Cliffs is situated in the southernmost part of the Jezero delta front [4]. There, we focus on the subhorizontal, sandstone-dominated (locally boulder conglomerates) series identified as fluvial topsets. They lie

unconformably on top of steeply dipping foresets (Fig. 3a). At Le Boulou, we observe a similar, yet better expressed, topset interval, mainly composed of boulder conglomerates with a sandy matrix and clasts locally up to ~2 m-large (Fig. 3b). We also observe a sharp truncation between topsets and underlying sandstone-dominated, steeply dipping foresets. While Franklin Cliffs showed a few preserved channel features, we cannot identify the same at Le Boulou for sure, but this might be only due to cross-section angle and presence of vegetation. We nonetheless identify in Le Boulou some imbrication of clasts as a consequence of flow drag during deposition, which has been observed at other places of the Jezero delta [4].

Conclusion: The coarse-grained deltas from the Roussillon basin in southern France offer an interesting analog to the western delta of Jezero crater. We notably highlight very similar facies due to nearly pristine

condition of the Roussillon deposits and poor if any bioturbation. The barely lithified outcrops from the Roussillon provide good references to compare similarly-sized deltaic morphologies, and explore original depositional parameters for Jezero delta.

Acknowledgments: The authors thank the Mars 2020 operations teams for their work on acquiring the images.

References: [1] Mangold *et al.* (2021) *Science* 374(6568), 711-717 [2] Gupta *et al.* (2023) *LPSC LIV* #2953; [3] Caravaca *et al.* (2024) *JGRp* 129(4), e2023JE008205; [4] Mangold *et al.*, (2024) *JGRp* 129(3), e2023JE008204; [5] Gautier *et al.* (1994) *CR Ac. Sci* 318(8), 1103-1109; [6] Clauzon *et al.* (2015) *Mar. Pet. Geol.* 66(1), 18-40; [7] Caravaca *et al.* (2024) *LPSC LV* #1246.

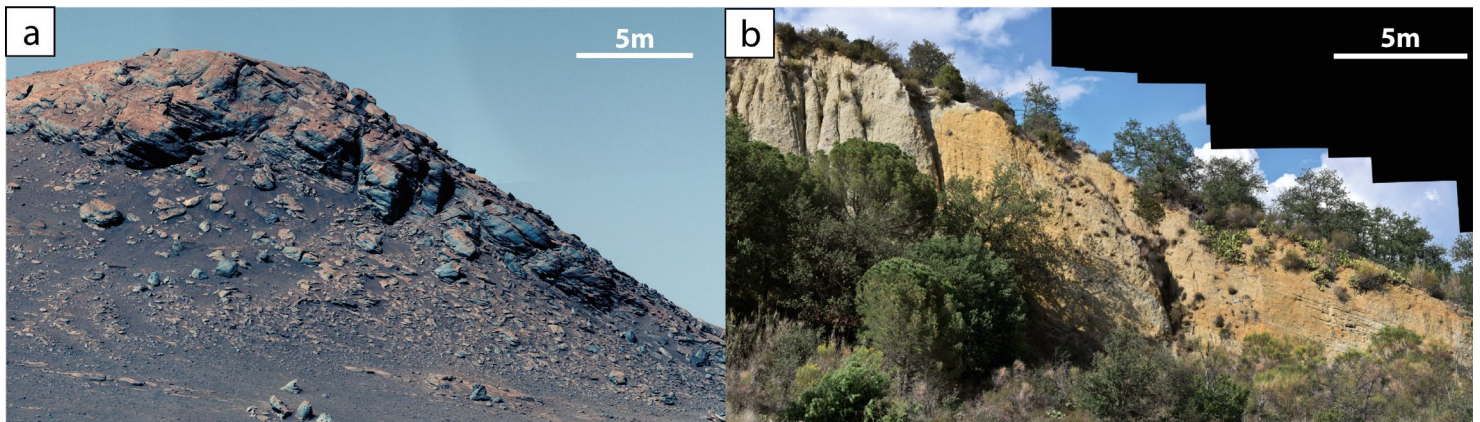


Fig. 2: Comparative view of the foresets series observed on top of Jezero delta at Pinestand Mountain (a, sequence zcam08726) and on the terrestrial analog in Ille-Sur-Têt (b).

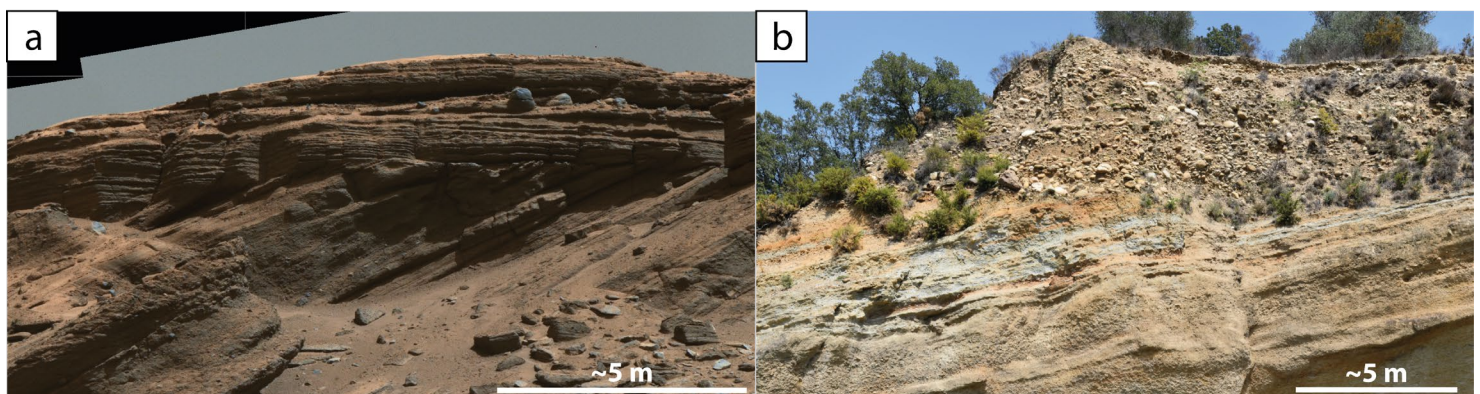


Fig. 3: Comparative view of the topset series observed on the Jezero delta front at Franklin Cliffs (a, reversed image, sequence zcam08705) and on the terrestrial analog at Le Boulou (b), highlighting the sharp foreset/topset transition.