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Reconstructing palaeo-meander fluvial deposits on the Western delta fan in Jezero crater, Mars

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Analysis of sedimentary deposits on Mars is central to reconstruction of ancient climates and habitability of early Mars. Jezero crater (18.4°N, 77.7°E) was recently selected as the landing site for the NASA Mars 2020 rover mission due to land in 2021. The ∼45 km wide crater, located in the Nili Fossae region, hosts a diverse array of geological units – sedimentary deposits of the western and northern fans, mafic floor unit, basin fill and carbonate unit. Sedimentary deposits within the crater are interpreted to have formed in an open-basin palaeolake system. The Western fan in the crater is proposed to be one of the major areas for detailed investigation and sampling by the rover. It likely holds important clues to the sedimentary history and palaeoclimate of late Noachian/early Hesperian – a period associated with major fluvial activity and potentially habitable conditions on Mars. While most of the Western fan deposits, exposed at the surface, are formed of a sedimentary unit comprised of channel-form sedimentary bodies, erosional windows through this unit reveal an underlying unit that shows evidence of deposition in fluvial point bars. Point bars are lithologically heterogeneous deposits that capture the evolution of the channel and allow for indirect estimation of palaeohydraulic parameters which is important in understanding palaeoenvironmental settings of the area.

Here, we utilise High Resolution Imaging Science Experiment (HiRISE) (∼25cm/pixel) images, and derived HiRISE Digital Terrain Models (DTMs) of ∼1 m grid spacing to characterise all the significant planform exposures of the point bar deposits on the Jezero Western fan. To further aid this investigation, 3D visualisation tools were employed. All exposures were divided into sectors, within which packages with coherent bedding plane traces were mapped out. We observed the packages to form arcuate rock bodies comprised internally of curved concentric strata. These bedding plane traces are interpreted as the intersection of bedding with the surface of lateral accretion bedsets within point bar deposits by comparison of their geometries with terrestrial planform examples of exhumed meander belts.

Our study analyses the various bedding geometries within the packages and their relationships with each other. The results suggest that these deposits record complex and diverse planform curvilinear bedsets as a result of different channel-bend migration patterns (expansion, rotation, translation and their combinations) of the meander loops. The observed channel bend migration patterns allow for estimation of likely planform evolution of point bar units with implications for how the river systems evolved and their flow orientations. Through critical assessment of these deposits, this study attempts at providing a detailed orbitally-derived characterisation of a key sampling unit for the Mars 2020 rover mission.