Introduction: From studies of large impact structures on Earth, a variety of different impactites, i.e., rocks that formed during a hypervelocity impact are known. A special impactite variety that can form during impact crater formation is the so-called pseudotachylite. These rocks are interpreted as the result of polyphase frictional melting and subsequent cooling that can take place on sliding surfaces during earthquakes, large landslides, and the tectonic collapse of impact structures; see, e.g., [1]. Pseudotachylites can occur as veins or dike-like outcrops in the central uplift or the crater wall, and comprise a microcrystalline or glassy matrix containing fragments of the wall rocks (see Fig. 1). The friction melt acts as a lubricant that allows the rocks to slip more easily along the fault plane during the modification stage of the crater-forming process.

Pseudotachylite can be confused with impact melt injected into the fractured target rocks of the crater cavity. Both can be present at an impact structure, and it may not be possible to distinguish between them in the field or even in the laboratory. For this reason, most of the considerations are valid for both impactite types that may be present in the Jezero crater rim. Pseudotachylite that formed near a simultaneously formed impact melt sheet conceivably contains an allochthonous component derived from the impact melt [3]. A possible pseudotachylite in the Jezero crater rim would most likely be from a topographically higher level in the impact structure than pseudotachylites found in highly eroded impact structures on Earth.

Jezero Crater and its Rim: Jezero crater is a Martian impact crater with a diameter of approximately 45 km. The crater is the result of an impact into the Noachian basement at the rim of the Isidis impact basin. Remote sensing data suggest that the Noachian basement contains low-Ca pyroxene and Fe/Mg-smectite [4]. Based on the diameter, Jezero crater most likely formed as a complex crater, although today no central uplift or apparent terraced walls of the rim (at least in large areas of the rim) can be recognized; this indicates a substantial degree of crater degradation and/or crater infill. The age constraints given in the literature for Jezero crater, which were determined using crater counting methods on a unit of the crater floor, differ greatly, see e.g., [5][6]. The Mars 2020 Perseverance rover is going to drive up the rim of Jezero crater sometime in 2024. For a possible traverse of the Mars 2020 rover up the Jezero crater rim, see Figure 2.

Potential of Locating a Pseudotachylite Sample: A pseudotachylite sample from the Jezero crater rim that formed during the crater forming impact could be used to obtain a radiometric age of the Jezero impact event. This would represent the first radiometric age of an impact structure from an in-place sample on another planetary body other than the Earth. This age would have important implications for other ages based on crater counting methods, as it would allow to calibrate the method based on the age of Jezero crater. In combination with ages that will be possibly obtained from the western fan samples, the age for the formation
of Jezero crater would constrain the timeframe from the crater forming event to the establishment of a habitable environment in the crater, i.e., the Jezero crater lake. On Earth, pseudotachylites were for example used to determine an $^{40}\text{Ar}/^{39}\text{Ar}$ age of 2018 ± 14 Ma (2σ) for the Vredefort impact structure [7]. Furthermore, pseudotachylite has been used to reconstruct the intensity of the magnetic field at the time of an impact event on Earth, e.g., for the Sudbury impact structure [8]. Such paleomagnetic investigations on a pseudotachylite sample from Jezero crater would also be useful for understanding the properties of the magnetic field during the early history of Mars.

**Where to Search for Pseudotachylite:** The Neretva Vallis inlet cuts through the western Jezero crater rim. In this region of the crater rim, lower areas of the crater rim are potentially exposed on both sides of the inlet valley. HiRISE images (e.g., ESP_077565_1985_RED – 25 cm/pixel) of this area show layered units that crop out at the crater rim [8].

![Fig. 3. Jezero crater rim layered units on the outer side of the western part of the rim. These structures show similarities to pseudotachylite from the terrestrial Vredefort impact structure as shown in Figure 1. The image is a HiRISE DTM visualized in PRo3D [10], with the possible rover traverse from Figure 2 marked in orange. The inset shows a detail of the original HiRISE image ESP_077565_1985_RED (25 cm/pixel). NASA/JPL-Caltech/ASU/MSSS/USGS/JR/VRVis/ÖAW](image_url)

It is not clear, whether these are sedimentary deposits from the inlet channel, or represent rocks from the crater rim. On the outer part of the western crater rim, several large areas show layered units (see Figure 3 and [9]) that resemble pseudotachylite outcrops known from Earth (compare to Figure 1). There are no spectral data from CRISM available for the region in question, which makes an interpretation from orbital data alone more difficult. Additionally, based on orbital observations alone, it is questionable if these possible pseudotachylites are from the Jezero impact event itself or pre-date it and represent impact melt dikes/pseudotachylites from the large impact that formed the Isidis basin. A fault cross-cutting the possible pseudotachylites, visible in the inset of Fig. 3, may have formed during the cratering process and may, therefore, indicate a pre-Jezero origin of the pseudotachylite.

**Conclusions:** There are interesting observations from orbiting spacecraft that suggest the possible presence of pseudotachylite at the Jezero crater rim. Whether a pseudotachylite possibly found in the rim is from the Isidis impact and, therefore, part of the pre-Jezero bedrock, or from the Jezero impact itself, may be difficult to discriminate in situ by the rover. However, in both cases it would represent a very valuable sample target for the Mars Sample Return Mission. Even if an Isidis-derived pseudotachylite (the matrix of which is denoted as megabreccia in the literature of the Jezero crater area) may have been reset by the Jezero impact, the clasts in the pseudotachylite may provide opportunities for investigations of the Nouchian basement. Additionally, the geologic context observed by the rover mission during the visit of the location of interest combined with terrestrial laboratory studies may allow for a distinction between pre-Jezero and Jezero-derived occurrences.

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