BECQUEREL CRATER RADIAL FAULTS: A POSSIBLE TARGET FOR METHANE SEEPAGE INVESTIGATIONS

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INTRODUCTION

Structural and stratigraphic features of Becquerel crater (Arabia Terra, Mars) suggest this area may be a possible methane release zone. The filling sequence of the crater shows a complex pattern of faults culminating on the top in a radial disposition: on Earth such a setting is often associated with methane seepage, thus further investigations may deepen this hypothesis, using also terrestrial analogues.

DATA & METHODS

The dataset used includes CTX, HiRISE and HRSC images and DEMs.
Raw data have been processed by means of the software *ISISIII*.
Stereo-models were obtained either from HiRISE PDS data or via ASP.
Observations were made using 2D and 3D ESRI GIS systems.

OBJECTIVES

- Stratigraphic analysis of the main outcrop (occurring in the southern portion);
- Sedimentologic reconstruction in order to define a possible scenario hosting the observed features;
- Terrestrial analogue;
- Constraints on the eventuality of methane seepage occurrence in view of the next exploration missions.

RESULTS & DISCUSSION

In the southern outcrop of Becquerel crater (Fig. 1) the stratigraphic analysis highlighted the occurrence of two main facies (Fig.2):

- *P Facies*: light-toned deposits characterized by planar bedding. Interpreted as the result of possible lacustrine/evaporitic deposition. Locally these deposits assume also a wavy aspect with alternations of different beds.
- *T Facies*: dark deposits with trough-cross bedding, arranged in lenticular bodies. More resistant to aeolian erosion respect to the P Facies. Interpreted as cemented aeolian deposits.

The structural features within the outcrop are often complex and characterized by high variability in the attitude. Despite the complexity also due to the erosion, it is possible to infer an extensional kinematic based on the displacement observed in 3D view. On the depressed top the faults occur showing all the different attitudes detected in the other sectors and result in a radial pattern (Fig. 3).

We propose that the normal faults organized in a radial pattern, especially on the depressed top, may represent a surface collapse in correspondence over a buried salt diapir.

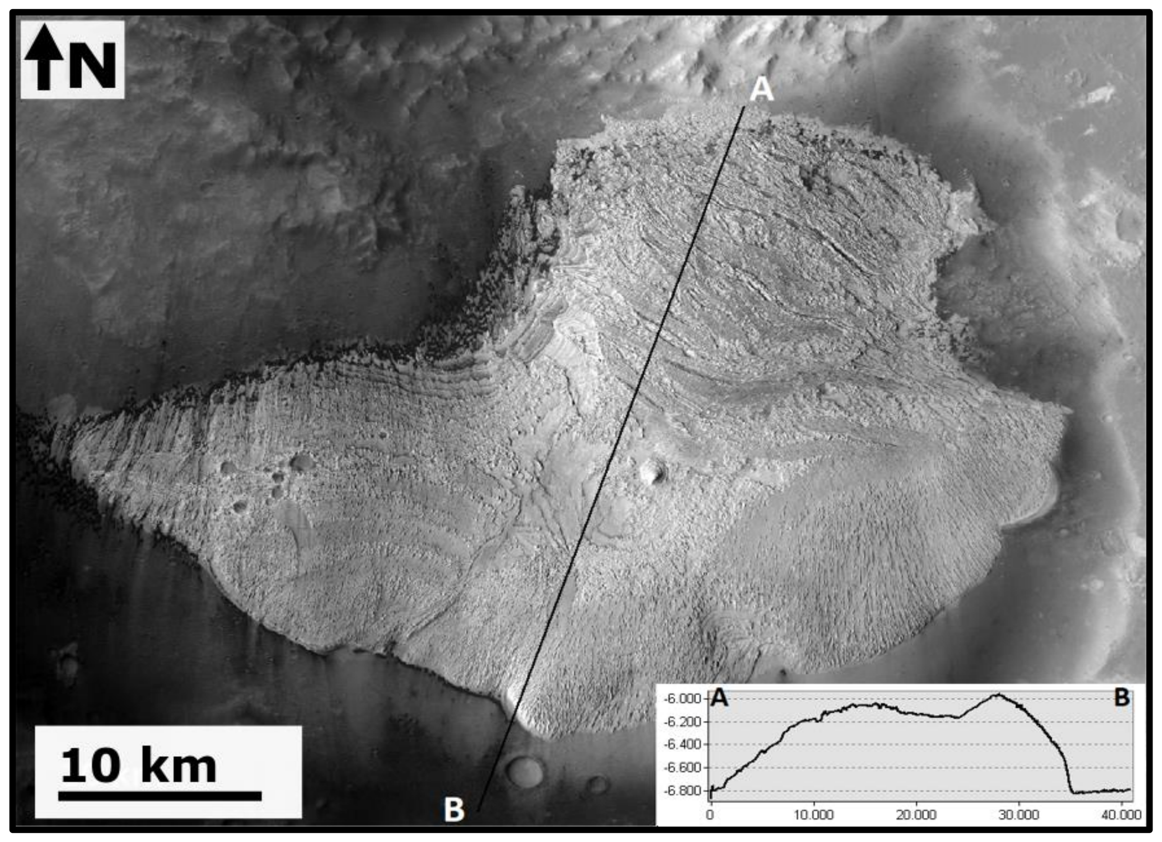

Fig. 1: The main outcrop of Becquerel crater. On the bottom right a topographic profile shows the positive relief associated with a depressed top. *HRSC h3231_0001.nd4.50.*

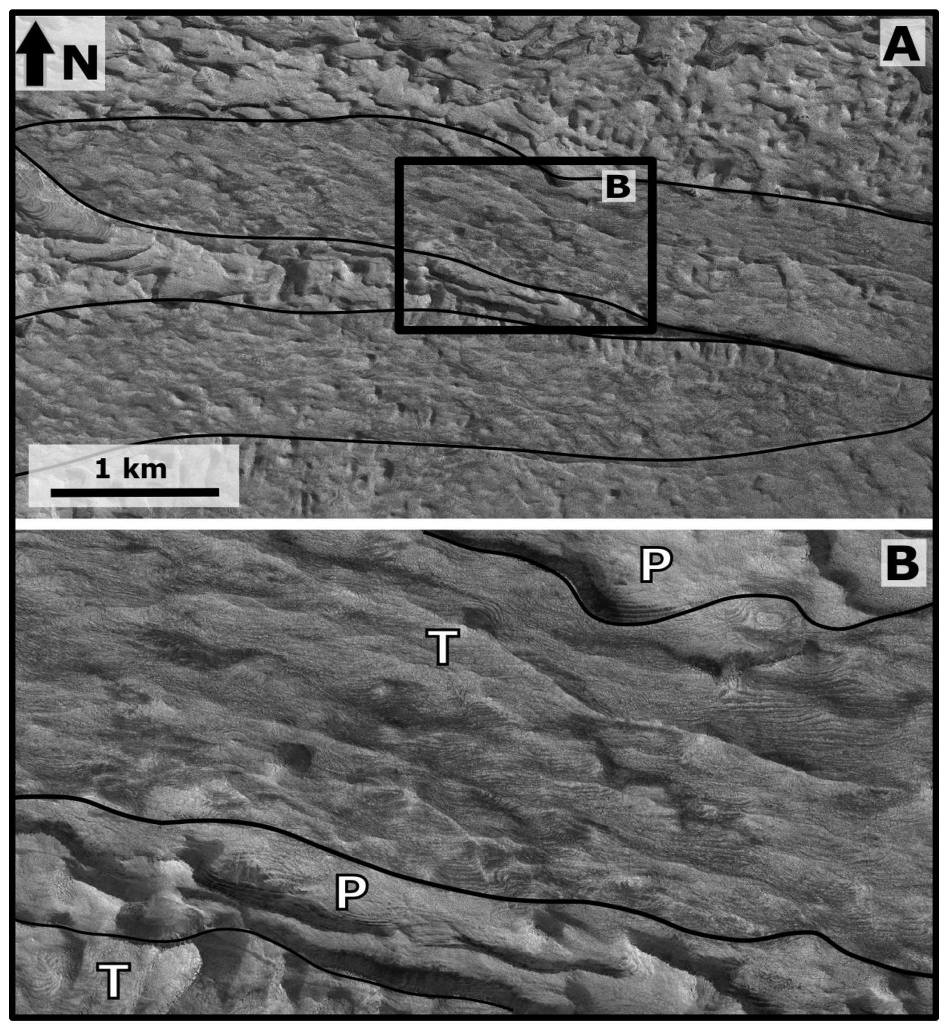

Fig. 2: A: Lenticular T facies bodies. B: Contact between P and T facies. HiRISE stereo images PSP_003656_2015 and PSP_005845_2015

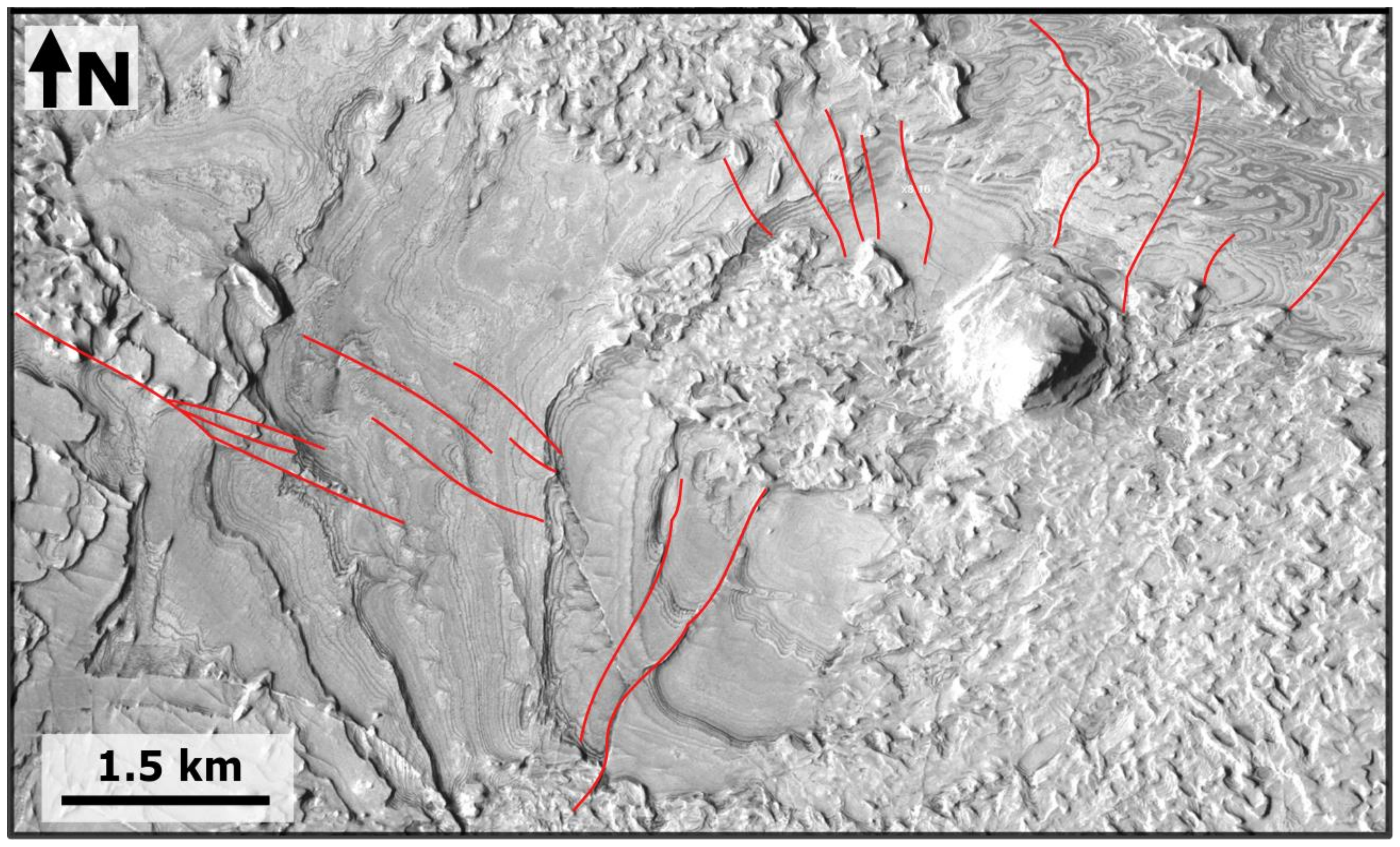

Fig. 3: Radial faults on the top of the outcrop. *CTX P02_001955_2016_XI_21N008W.*

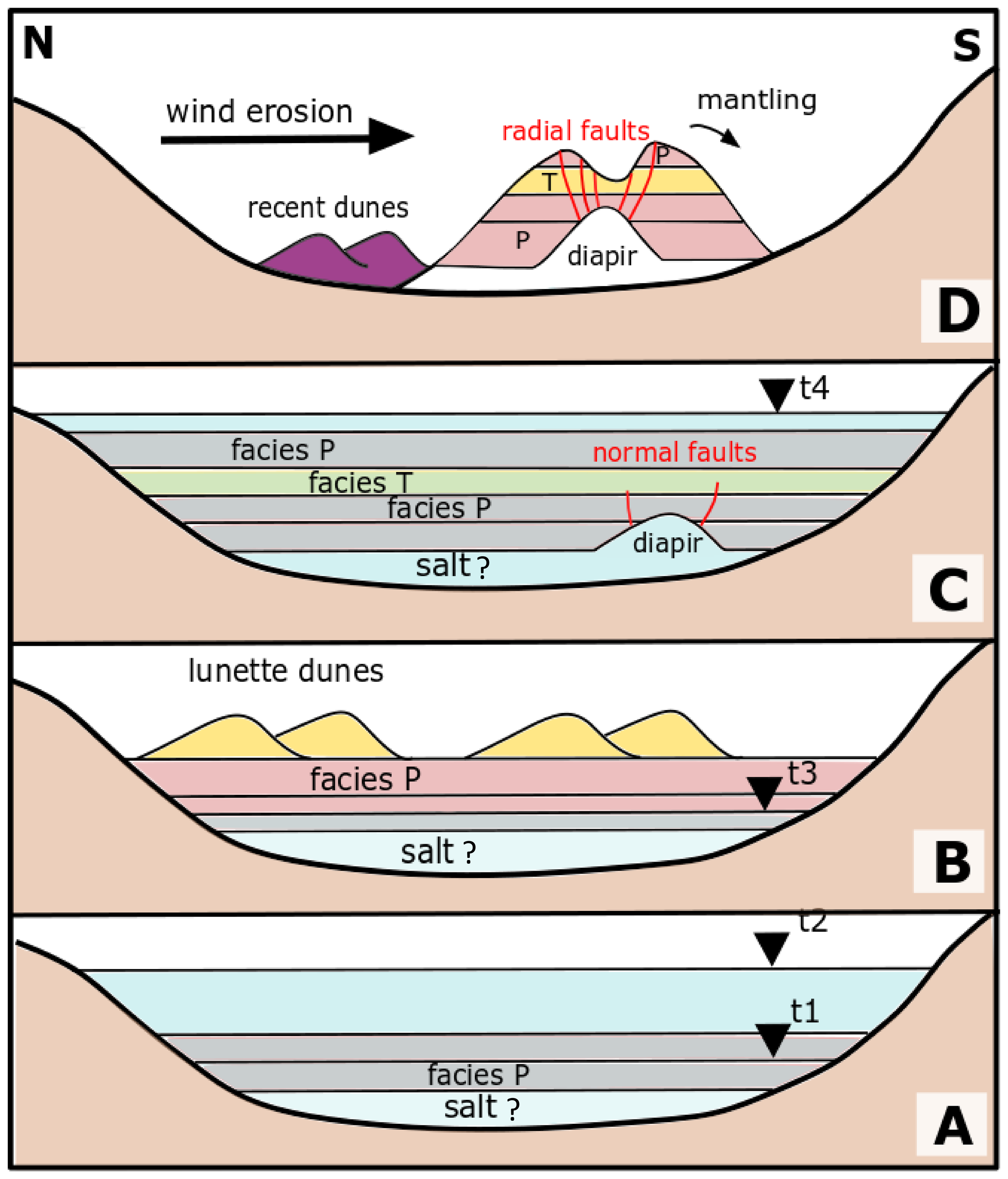

Fig. 4: A possible scenario for Becquerel crater. **A**: Evaporitic environments and salt deposition at time 1. Rise of the groundwater table and lacustrine deposition (P facies) at the time 2. **B**: Groundwater table drop, subaerial exposure and deposition of barchan dunes (T facies) at time 3. **C**: Alternations of P and T facies producing significant overburden for the salt. Salt diapirism producing normal faults at time 4. **D**: Final drying and wind erosion and deposition.

On Earth radial faults, over collapsed salt diapirs or uplifted fault blocks, are often associated with natural gas (methane) seepage.

In Fig. 4 a possible sequence of events is provided. During the early filling stage within the crater, groundwater table oscillations may have produced environments from playa-like to lacustrine, with deposition of salt and lacustrine/evaporitic deposits corresponding to the P Facies. Later, a groundwater table drop may have produced subaerial exposure and deposition of aeolian deposits corresponding to the T Facies. Before the final drying and the subsequent wind erosion, the estimated overburden of the salt might have been greater than 800 m, which is the current thickness after billions of years of aeolian erosion. The density contrast due to the lithostatic loading would have triggered the salt diapir rising. A depressed top with radial normal faults can be indicative of the reactive stage of the diapirism. A terrestrial analogue for reactive diapirism is in the Gulf of Mexico, where the salt diapirism causes normal radial faults and the collapse of the overburden rocks, thus developing intense natural gas seepage.

The Becquerel radial faults could then be the object of gas seepage investigations through orbital methane detection (e.g., Mars Express-Planetary Fourier Spectrometer, ExoMars-TGO). It will be interesting also to compare this hypothesis with other processes possibly responsible of such a radial pattern.

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49th LPSC