AN ERODED PEAK RING IMPACT RECORDING A TSUNAMI ON EARTH: ROCHECHOUART.

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Introduction: Rochechouart has been known as an eroded impact structure since 1969 [1]. The structure is located on the western margin of the Hercynian Massif Central [1-2]. The ages determined in the last decade agree with a late Triassic event (between 207 and 201 Ma, within error limits [3-5]). Despite it being an obvious structure of interest and having excellent accessibility, Rochechouart has received considerably less attention than other large terrestrial impact structures, and many questions have remained unanswered, such as what were its initial morphology and size [2]. The work related to the preparation of the 2017-18 drilling campaign and the preliminary results thereof have allowed to reconsider the interpretation of the structure.

Main results: Over 540 m of cores were recovered from 8 sites. They intercepted both the crater fill deposit and the underlying target rocks (see [6] and Fig. 1). Despite the wide variety of target debris encountered in the various impactite lithologies sampled, only metamorphic and igneous clasts are encountered. The cores confirm the strictly crystalline character of the Rochechouart target. The paleogeographic data suggest the impact took place onto a narrow isthmus connecting the Hercynian Massif Armoricain and the Massif Central, separating a shallow intracontinental sea (Raethian Sea) to the North from the Tethys to the South (Fig. 1). Rochechouart at the time of the impact was located next to the 30th parallel, which nowadays runs across the middle of the Sahara platform. The climate was arid [10-12].

The drillings confirm the sub-horizontal nature of the impactite deposits in the structure. The local variations of altitude of the crater floor compare to the regional variations and the small 0.5° apparent inclination to the North is seemingly not significant (Fig. 2).

Combined with surface exposure of the crater floor [2], results confirm the absence of a central stratigraphic high. The sub-circular horizontal deposit fills a topographic low, from which it can be deduced that the Rochechouart impact structure does not match a central peak crater, but rather correspond to a central ring crater (Fig. 2). Erosion has removed all "upper" structures of the crater (rim, annular through and annular ring)(Fig. 3) but abated, at least in places, before reaching the bottom of the central depression, allowing the complete sequence of impactite lithologies to be exposed there today [2].

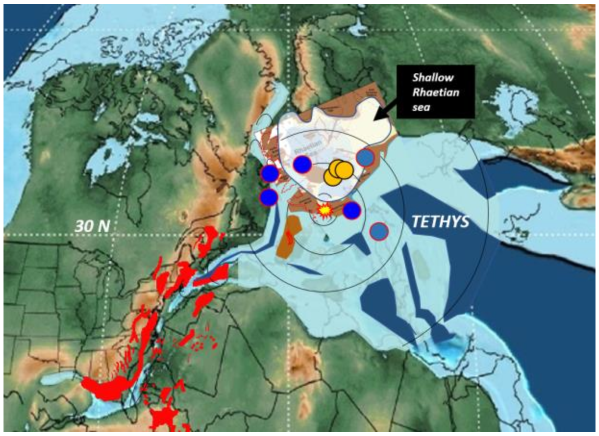

Fig. 1: Paleogeographic map for the end of the Triassic, modified after [7-9]. Dots: tsunamite/seismites attributed to the Rochechouart event (blue [3], yellow [9]). Red: Major basalt flows related to the CAMP large igneous province.

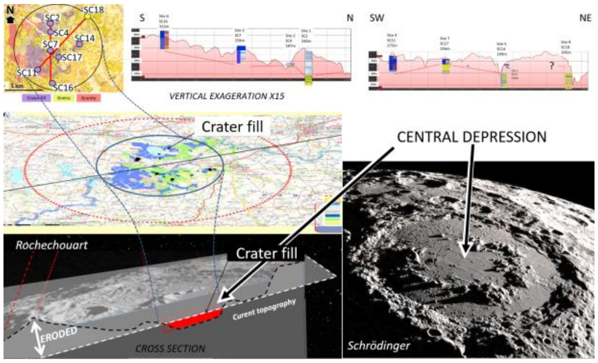

Fig. 2: Top: drilling sites and section accross the Rochechouart crater fill deposit. Red line: crater floor. Bottom: interpreted cross section of the initial crater (left) and the lunar Schrödinger basin for comparison (right)

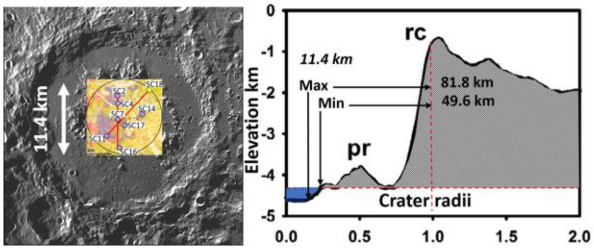

Fig. 3: Left: map of the Rochechouart breccia deposit with the dilling location superimposed onto a vertical view of Schrödinger for comparison. Right: profile of the Schrödinger crater floor after [13] with peaks (pr) and rim crest (rc) used as scale for the Rochechouart deposit (blue) remaining after erosion (grey shaded = minimun erosion)

Considering the 11.4 km diameter of the remaining central deposit at Rochechouart, the range of possible initial crater diameter of Rochechouart (~50-80 km) can be inferred form the morphometrical characteristics of peak ring craters on planetary surfaces, such as Schrödinger basin on the Moon (Fig. 3).

While the cores obtained at the center of the structure (SC7, 11 and 17) and in the southernmost area (SC16) all start with a red, clast-rich horizontal impact melt layer covering various melt-bearing breccias, the northernmost drilling (SC2) does not (Fig. 3 and 4), in agreement with surface exposures [2, 14-16]. Instead, it intercepts a ~100 m thick melt-clast bearing breccia, with two distinct units according to texture and melt-clast content. The upper 40 m thick melt-rich unit displays a series of layers with variations in granulometry and matrix content (Fig.4), contrasting with the underlying unsorted/ungraded melt-poor suevite [6]. This can be interpreted as the signature of an intense reworking of the top part of the crater deposit by a tsunami. These observations add credit to the interpretation of a variety of tsunamites in the EU by [3] and more recently by [4], which have been attributed to the Rochechouart impact. Such deposits have previously been interpreted as related to the CAMP volcanism. Tsunamites of age matching the age of Rochechouart are also distributed around the impact site and seem to be better related geographically with the Rochechouart event than with the CAMP volcanism that developed further to the southwest (Fig. 1). When the impact occurred at the margin and in the direct prolongation of the developing narrow ocean, could it have weakened the crust at the right spot leading to sudden acceleration of the opening of the Atlantic after the Trias?

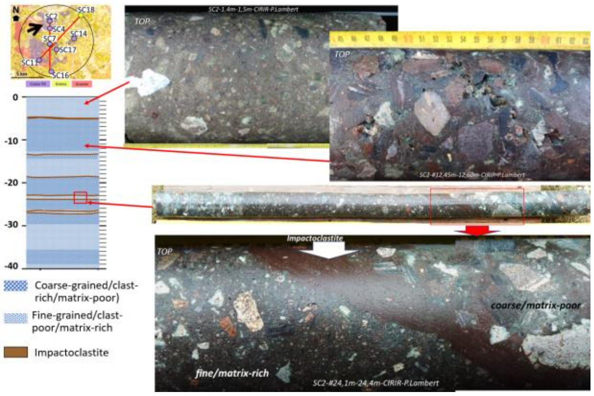

Fig. 4: Left: Schematic log of the upper part of the Chassenon core (SC2). Right, optical view of the core at ~1.5, 12.5 and 24.5m depths illustrating the sorting and changes in textures in the deposit.

Eventually the leading specialists of marine impact within the CIRIR group are currently studying the Chassenon cores. Preliminary results suggest the Rochechouart area may have been fully coved by sea at the time of impact [17].

Conclusions: The first drilling campaign at Rochechouart is more than keeping its promises. Similarities with Chicxulub were already mooted and advocated the drilling project at Rochechouart [18]. The preliminary results of this campaign lead to even more similarities. The size and previously held structural differences between the two impact structures are "shrinking". Rochechouart must have been larger than currently thought. It is not a central peak crater but rather a peak ring, like Chicxulub. Unlike Chicxulub affecting a mixed target, the drillings confirm the strict crystalline character of the Rochechouart target. The drillings reveal that Rochechouart, like Chicxulub, must have triggered a large tsunami. Finally, it appears that both the climate and the paleoenvironment at these two sites may have been similar, too.

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