

## THE INITIAL ROCHECHOUART CRATER

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**Introduction:** To date, there is no consensus regarding the initial size and shape of the Rochechouart initial crater. The 23 km appearing in the Earth Impact Database are not constrained by direct evidence and a wide variety of sizes has been advocated in recent years both regarding much larger and much smaller sizes. How can it be?

**Datas:** Allochthonous breccias meeting all the petrologic characteristics of impact crater deposits are found over a 12 km wide zone. This constrains the minimum possible size of the initial crater. Yet, the structure is deeply eroded and thus, it must have been originally larger. This can be addressed indirectly considering regional paleogeography and geology. The crater fill deposit is exclusively composed of basement material. This is consistent with paleo-environmental data suggesting the impact, dated between 207 and 201 Ma by a variety of authors [2-5], took place on land, onto a narrow isthmus against open sea to the SW and a shallow Rhaetian sea to the NE. Shallow water rapidly covered the impact area depositing sediments that protected at least the deepest part of the crater until the sea retreated fully some 100-120 Ma ago. Gravimetry by [6] indicates a -10 mgal Bouguer residual anomaly centered on the breccia deposit. Related to intense fracturing and porosity in the target below the crater floor, the anomaly expands well beyond the exposed breccia deposit and affects a 25-35 km wide circular zone that may be regarded as the minimum imprint of the initial impact crater. Shatter cone distribution was proposed by [7] to estimate the apparent diameter of eroded complex craters on Earth. This leads to a 32 km diameter estimate for the original crater. While the crater floor of simple craters (SC) and peak ring (PR) structures is characterized by a “central low”, central peak craters (CP) are characterized by a central uplift that may provide a practical constraint on crater size/shape, when a crater floor is exposed. This is precisely the case at Rochechouart due to river drainage and drillings. The crater floor stands at 225 m  $\pm$  75 m over the entire breccia deposit including at the center of the structure. This excludes Rochechouart as a CP crater, as if it represented such a structure, the floor at Valette would rise by 0.5-1 km above an annular depression. Being too large by far to be a SC, the only alternative left is a PR crater, of which the crater rim, the annular trough and annular ring were removed by erosion, leaving at least in places, the bottom of the crater fill deposit in the central depression. This suggests an initial crater at least 50-80 km in diameter. Recent multiscale geoelectrical studies of the Rochechouart impact structure [8] concluded that all the target exposed beneath the impactite deposit corresponds to the collapsed central uplift of the Rochechouart crater. This also suggests a large crater interpreted as a transitional CP-PR structure [8]. Yet, the SC2 drill core at Chassenon revealed a complex graded texture in the upper 80 m of the suevite deposit with rapid changes in granulometry in the first 40 m. Using a visual line logging method developed to investigate impact deposits in several marine-target impact craters, [9] suggested a marine target setting for the Rochechouart impact, assessed the target water depth as ~200 m and the initial diameter of the crater as 12 km.

**Discussion:** Depending on the criteria used, the size and the shape estimates for the initial Rochechouart impact crater vary dramatically. Also the environment, considered until now to have been shoreline yet continental, has been questioned by the sedimentological features observed in the SC2 core. This in turn, raises questions about the generally accepted age of the impact, and the knowledge of the paleogeography of the area at the turn of the Jurassic. A marine impact with a minimum 200 m thick water cover seems hardly reconcilable with a Rhaetian age, but might suggest an Early Jurassic age consistent with ~195 Ma ages given by some zircons recovered in impact melts rocks [3, 5, 10]. Nevertheless a 12 km diameter does not fit the apparent lack of central uplift. If we increase the size by a factor 2-4, this would require to increase the water depth by even more, which does not seem possible for the entire time span. However, what could be tested is the possible environmental effect of an impact into the vicinity of a deep sea. It is our case. Could the impact have produced a surge and/or a refracted tsunami wave capable to mobilize enough water to explain the observed features in the SC2 drill core? Are we sure these features cannot be produced by an impact on land? Could the late excavation stage, and/or the rapid uplift followed by collapse of an enormous quantity of materials during the modification stage of cratering have been capable of stirring and transporting large sized blocks as a fluidized megabreccia? Could phreatomagmatic explosions have been able to reinforce the process or be a major contributor to complex deposition disturbances as observed in the SC2 drill core? Such explosions may be conceivable when considering a process where fracturing below the crater floor could have opened conduits for nearby seawater to interact with the hot deposits at the bottom of the crater?

**Conclusion:** The above review leaves us with more questions than answers. It calls for more efforts and more studies to understand the Rochechouart event and the environment at the time of impact.

**References:** [1] Lambert P. (2010) GSA Spec. Pap. 465, 505–541. [2] Schmieder M. et al. (2010) MAPS 45, 1225–1242. [3] Horne A. (2016), ASU Master Thesis, p 63. [4] Cohen, B. E. et al. (2017) MAPS, 52(8), 1600–1611. [5] Rasmussen et al. (2020) *Geochimica et Cosmochimica Acta*, 273, 313–330. [6] Pohl J. et al. (1978), *Meteoritics*, 13, 601–604. [7] Osinski G. R., and Ferrière L., (2016), *Sci. Adv.*, 2, e1600616. [8] Quesnel Y. et al., (2021), *Geo-chemistry, Geophysics, Geosystems*, 22, e2021GC010036, [9] Örmö J. et al., (2021), *EPSC*, 15, 55. [10] Guerrero D. et al., (2022), *ICF-CIRIR 2022*.