DRILLING THE ROCHECHOUART IMPACT STRUCTURE. P.Lambert, Sciences & Applications, 33800-Bordeaux, France, lambertbdx@numericable.fr, centre-scientifique@rochechouart.com

Introduction: Recognized as an eroded impact structure in 1969 [1], the 23 km Ø Rochechouart structure dated 201 Ma +/-2 [2] is among the most accessible large impact sites on Earth, both in terms of geography and geology [3, 4]. However, it has neither been drilled for impact research nor been studied comprehensively yet. Multiple scientific drilling to shallow depths will be funded by the "Réserve Naturelle Nationale de l'Astroblème de Rochechouart-Chassenon" (RNN) and operated by Center for Research on Impacts and on Rochechouart (CRIR) [4-5] planned to open early 2016.

General aims: The drilling campaign aims to boost the multi-disciplinary scientific study of the Rochechouart impact structure that preserved a wide variety of impact rocks at different erosion levels [2]. Curatorial facilities at the CRIR and NNR will provide opportunities for ground truth data mining by providing access to the drill cores and associated data to the scientific community. Completion of the drilling program is targeted between mid-2016 and late 2017.

Drilling programme: Owing to the erosion level and the natural state of exposure at Rochechouart, there is no need for preliminary geophysical prospection. Deep drilling is not required either. A series of shallow drillings (50 to 150 m deep) is planned. A total of 8 sites are currently selected along a 10 km N-S traverse of the breccia deposit filling the inner center of the crater (Fig. 1). At all sites, drillings will intersect the crater floor and stop some 30 m beneath. Cores will be 80 mm in diameter for the single "deep" drilling (up to 150 m at site 1) and for the intermediate ones at all the other sites (up to 50 m). Several shallow 106 mm cores (1-10 m) are also planned at the various localities for technical and/or scientific purposes. The final number and depth of drilling will be determined on site according to scientific findings and practical constraints. The cumulated length of the cores should reach over 300 m, possibly up to 350-400 m.

Scientific objectives: Mapping the level and distribution of shock-metamorphic overprints at each vertical segment in the target rocks and comparing them at different distances from the center should yield constraints for the initial size of the crater, the positioning of the center and its initial morphology (basic field geology seems to indicate that a central peak is absent at Rochechouart [3]). The current remains of the crater fill forms a continuous, flat lying stratigraphic unit at the same elevation +/- 50 m over the crater floor, including at the center [3, 8]). Each core will give access to the eventual trace of the projectile as described by [6] and [7] at the crater floor interface respectively at Ries and Rochechouart. Despite the limitation in depth, we anticipate the recovery of a variety of impact breccia dikes and pseudotachylites outcropping at various localities [9] and observed in an ancient shallow drilling for ore prospection [3] cored 3 km further south of site 6 (Fig. 1). Nature, age and origin of hydrothermal veining and breccias should also be accessible at each site or at Champagnac (site 7 Fig. 1), where they have been described previously [10].

The complete range and the full sequence of preserved impact rock deposits will be intersected, enabling a comprehensive understanding of the structures and the petrologic inventories of these deposits. Penetrating systematically the target, the cores will constrain the relationships between allochthonous and (para-)autochthonous impact rocks (see also discussion in [3]). Drillings at sites 3 and 4 (Fig. 1) will intersect the vesicular impact melts that are exposed in a 3 km Ø zone near the geometric center of the impact structure [3, 8]. These impact melts rest directly in contact with the crater floor and were liquid after crater readjustment despite incorporation of at least 10% of "cold" lithic clasts that are still recognizable and forming immiscible, silica rich melts within the matrix melt [3] (Fig. 2). Sites 1, 2 and 8 are located at distances of only 2 km to the N and E of the vesicular melt exposures (Fig. 1), yet the material at the bottom of the crater is "cold" and only composed of lithic debris forming an approximately 40 m thick blanket [3, 8]. At sites 1 and 3, the blanket of lithic debris is covered by a melt-bearing impact breccia with a lithic debris matrix and lithic clasts similar to those found in the lower lithic debris blanket unit, plus 10 to 15 vol.% of very homogeneous, largely altered glass (unit referred as to "top suevite" [3]). The deepest core at site 1 will intersect the complete stratigraphic sequence, including the impactoclastites at the top of the sequence [3, 8]. Understanding the nature, the geometry and the mechanics of the impactoclastites, that of the various breccia units as well as that of the variety of oriented mesostructures [including elongated melted clasts and bubbles in impact melts and faint bedding observed locally in lithic matrix breccias (Fig. 3)] are among the numerous questions that can be addressed with studies of the drill cores. Sites 5 and 6 will transect a massive impact melt rock unit referred as to basal impact melt" by [3] that is distinct from the breccia deposits near sites 1, 2 and 8, yet in a similar position relative to the central and vesicular melt zone (Fig. 1). This massive impact melt unit is characterized by a large proportion of clasts, including melt clasts [3, 9]. Owing to the amount and preservation states of the lithic components, the initial equilibrium temperature of this unit appears having been lower than in and below the vesicular melt bodies at sites 3 and 4; nonetheless, the igneous microstructure of the matrix [9] indicates slower cooling. Eventually, thermal conditions, thermal gradients, nature and composition of circulating fluids should be accessible via petrographic and geochemical studies of the material recovered in and below the deposits. Access to fresh samples in a variety of thermal environments should allow revisiting and confirming both the age of the impact and the identification of the projectile. It should also provide the key to "mapping", measuring, and interpreting the relative mobility of Platinum Group Elements (PGE) during cooling [3, 4]. It should enable identifying the PGE carriers and the mechanisms associated with their dispersion during impact and hydrothermal alteration. Comparison with altered material at the surface should provide the means for identifying and deconvoluting the superimposed incidence of surface alteration in order to evaluate and remove this incidence when only more or less altered material are available for studies, which is the usual case at Rochechouart and at other terrestrial and planetary impact craters.

Research opportunities: A Rochechouart task force is currently being assembled for identifying, developing, and promoting the research opportunities associated with the drilling program and with the material made accessible to the scientific community via NNR and the CRIR. It will be composed of scientists willing to cooperate on a volunteer basis (yet contractual and official), with the CRIR and under its authority, in the implementation of a research activity in the territory involved by the Rochechouart Impact. Members of the task force will organize collaborative research projects and proposals and will carry out research; CRIR will provide the local support, sample material and the general guidance with the drilling programme. In that context, we encourage any individual and/or group to contact us if they are interested in getting involved in the study of the Rochechouart impact or in joining our task force. Beyond petrographical and geochemical studies, our drilling campaign offers opportunities for a variety of other studies, including geophysics*, hydrology, soils, archeology, etc. In that framework, we will be happy to receive proposals for including core-logging instrumentation or adapting the drilling program to specific needs (*Rochechouart still awaits a comprehensive geophysical investigation).

References: [1] Kraut F. (1969) Geologica Bavarica 61, 428–450. [2] Schmieder et al. (2010) MAPS 45, 1225–1242. [3] Lambert P. (2010) GSA Special Paper 465, 505–541. [4] Lambert P. (2015) LPSC 46th, Abst. #1915. [5] Lambert P. et al. (2014) MAPS 49, Abst. #5171. [6] El Goresy A. and Chao E.C.T., (1977) Geologica Bavarica 75, 305-321. [7] Horn W. and El Goresy A. (1980) LPSC 11th, 468-470. [8] Lambert P. (1977) EPSL 35, 258-268. [9] Lambert P. (1981) Proceedings Multi-ring Basins, LPS, Schultz P.H. and Merrill R.B. eds., 59-78. [10] Reimold et al. (1987) JGR 92, 737-748. [11] Sapers et al. (2014) MAPS 49, 2152–2168. [12] Chèvremont P. et al. (1996) Rochechouart map 1/50000, BRGM, 172 p.

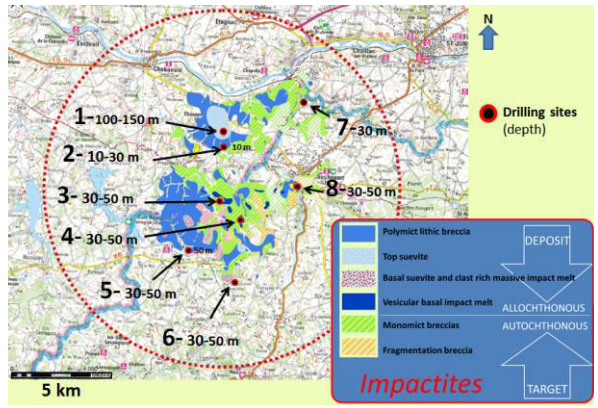

Fig.1: Geologic map of the impact deposits and impactites simplified after [12], and location of the drilling sites.

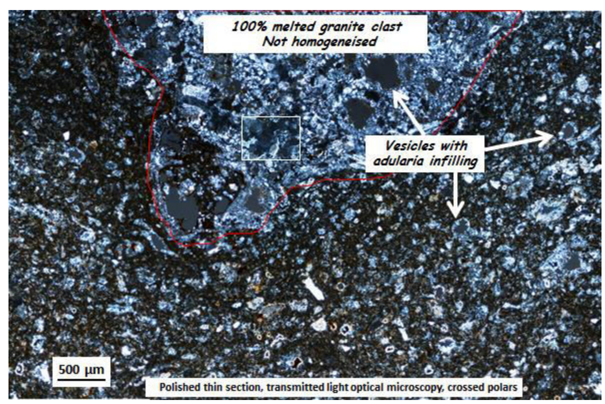

Fig.2: Micrography of the vesicular melt at sites 3-4.

Fig.3: Apparent sub-horizontal "stratifications" in lithic deposits. Left: interstratified pseudo-crossbedding in the top suevite near site 1 (see Fig.1); right: polymict lithic unit at the base of the sequence near site 2 (see Fig. 1).