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The Rochechouart-Chassenon impactite, France. A laboratory for Early life in hydrothermal veins?

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Abstract

In order to evaluate the exobiological interest of hydrothermal circulations associated with large impact craters on Mars, it is necessary to make analog studies on Earth. In this regard, the Rochechouart-Chassenon impactite in France is selected for further investigations.

1. Introduction

The surface of Mars, like the surface of all other bodies in our solar system except Earth and Venus, is covered with many meteorite impacts, a few millimeters to several tens of kilometers in diameter. The pressure wave due the meteorite impact causes very important changes in the upper layers of the planets, especially the formation of impact breccias. At an early stage when the water was still present on the surface of Mars, fluid circulations can have been favoured, contributing to the gradual cooling of the impacted rocks. The circulation of hot and mineralized solutions for thousands of years can in turn have promoted the emergence or development of life.

1.1 Location

The Rochechouart-Chassenon impact structure in France is located within hercynian crystalline basement rocks in the French Massif Central. The structure is eroded and shows no morphological evidence for a central uplift nor for a preserved crater wall. Based on the distribution of impact breccias and shocked basement rocks however, the crater diameter is assumed to have been 20-25 km and its centre was located at about 4 km west of the Rochechouart city [1, 2]. The meteorite could have fallen either in a very shallow sea or in a continental area, as indicated by the absence of nearby Triassic and Lower Jurassic sediments [2]. The age of the impact crater is Norian, in the Triassic period, in the time range 214±8 [3] and 201±2.4 Ma [4].

2. Materials

We want to search for the potential development of bacteria in hydrothermal cracks associated with the Rochechouart impact crater. The site is deeply eroded and allows access to underlying host-rocks. The latter consist of diverse basement rockswhich were little affected by later tectonic processes and remained in a continental setting. They are cut by numerous hydrothermal cracks. On the northern rim of the crater, the Champagnac quarry crosscuts the contact zone between the crater bottom and underlying plagioclasic paragneises. This quarry displays pseudotachylites, hydrothermal breccias and numerous carbonate and quartz veins formed in the crater and underlying basement by relaxation following to the compression wave (Figure 1).

Figure 1: Photography of hydrothermal veins in a massif granular rock. Note the breccias structure and locally the geodic aspect of the vein filling.

Pseudotachylites were formed above 700^{o}C. Hydrothermal veins consist of quartz, carbonates, sulfides, fluorite and barite (see detailed description in citebib4). The latter veins were probably formed below 300^{o}C, as suggested by [1]. The circulation warm solutions in the 100^o-30^{o}C temperature range can have favoured (the emergence and/or) renewed life development at the Norian.

3. Conclusions

In this work, we want to study the morphology of fluid inclusions in transparent minerals from impacted rocks and hydrothermal veins and breccias from the Rochecouart meteorite crater. The objective is to describe deformation and re-equilibration features of fluid inclusions related to the Hercynian basement rock history, and to constrain the composition, P-T conditions and exobiological potential of post-impact hydrothermal circulations.

Acknowledgments

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