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# Paleo-pockmark with anomalous *Peregrinella* brachiopods and polygonal faults : a new site in Rottier, in the Hauterivian of Vocontian basin (SE France)

Jean-Loup Rubino\*<sup>1</sup>, Jean-Claude Daumas\*<sup>2</sup>, and Robert Laudet\*

<sup>1</sup>Institut des Sciences de la Terre de Paris (ISTeP) – Institut National des Sciences de l’Univers, Sorbonne Université, Centre National de la Recherche Scientifique – France

<sup>2</sup>Centre Lucien Febvre (UR 2273) – Université de Franche-Comté – France

## Résumé

We know that *Peregrinella*, one of the largest brachiopods, are systematically related to methane seeps (Mascotay 1980; Kiel et al. 2014). Rottier is a classical reference site, where faunal lenses have long been reported (Lory 1861; Paquier 1900) and are well-described and accurately dated as late early Hauterivian (Thieuloy 1972). Thanks to landslide, a new exposure has appeared in Rottier on the northern flank of La Charce syncline in Haute Huchette hill, 500m SE of the previously investigated sites. The new site reveals, along a steeply inclined structural surface, a circular feature 5m in diameter surrounded by a 50cm high rim. Inside the depression, brecciated limestones form bumps, some full of *Peregrinella*, which are rare outside the depression on the rest of the nicely-exposed bed. Initially interpreted as a slump (Daumas et Laudet 2020), we reinterpret this feature as the trace of pockmark formed on the paleo-seafloor. This is supported by the shape of the feature, which is slightly depressed, and the occurrence of breccias derived from the well-bedded underlying series. The hole is filled by hemipelagite muds. Past isotopic analyses ( $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$ ) of the *Peregrinella* shells have clearly established that the carbonates are methane derived (Kiel et al. 2014). In addition the vent is seated in the middle of a network of polygonal fractures which are well-expressed on the structural surface. Therefore is it tempting to relate these features and propose that the site contains a polygonal faulting cluster and associated pockmarks, in which the expulsion of methane allowed the local development of anomalous fauna. The breccia and rim suggest an initial explosive activity, followed by long-term methane leakage at low rates as would be required to sustain the *Peregrinella* life oasis. Our findings definitively establish the Vocontian basin as a world class place for outcrops study of Mesozoic fluid escape features. This discovery invalidates past interpretation of direct fault related hydrothermalism (Lemoine et al. 1982) and cross-validates the major role of pockmarks (Gay and Migeon 2017) in fluid transfer in sedimentary successions.

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\*Intervenant