

Probabilistic Analysis of Sutural Lines Developed in Ammonites. An Example: Lower Jurassic Hammatocerataceae

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Motivations Ammonites are extinct ectococled molluscs belonging to the Class Cephalopoda which lived during the Mesozoic Era. Their usefulness in Jurassic and Cretaceous paleontology and biostratigraphy study is widely proved. For this reason, they are studied by several authors worldwide in order to achieve information regarding their habitats and climate of past world. Coherent upper conditional previsions defined with respect to Hausdorff outer measures are used to make a probabilistic analysis of the paleo-environmental causes that generated complex sutural lines. In particular, the role of hydrostatic pressure is studied.

Sutural Lines The shell of ammonites is sub-divisible in three parts: protoconch, phragmocone and body chamber. The phragmocone is divided in chambers separated by septa. The geometric projection of septum on the inner side of the shell is the sutural line. Every sutural line is characterized by alternation of several elements, named saddles and lobes, which reflect a fractal geometrical development. Sutural lines of Toarcian (lower Jurassic) ammonites are made of almost two separated groups. The first is close to mathematical model of the von Koch curve and the latter is close to mathematical model of the Cesaro curve [1]. These two models are associated to different hydrodynamic arrangements which correspond to two different life strategies. The von-Koch-sutural-line is related to good swimmer ammonites which show hydrodynamic features as oxycone section, developed keel, sinuous ribs and short body chambers [4]. The Cesaro-sutural-line is related to no good swimmer ammonites which are characterized by no hydrodynamic features as rounded sections, little keel, strong ribs, spines and very long body chambers [2].

Probabilistic Analysis In order to study the paleo-environmental causes of the complexity of the sutural lines, we interpret ammonites as complex systems whose evolution during time is described by a finite

family of contractions; the attractor of this family represents the sutural line, whose complexity is measured in terms of Hausdorff dimension. The hydrostatic pressure is represented by a random variable and we calculate the Choquet integral of this random variable given the sutural line, which is the conditioning event [3]. We consider a constant pressure and a strictly monotone pressure, corresponding to different life style. Different cases are studied according to the complexity of the sutural line.

Conclusions The results show that the Choquet integral of the hydrostatic pressure given the sutural line is a mathematical tool to describe different life styles of ammonites, which determined the complexity in the sutural lines.

Keywords. Ammonites, sutural lines, Toarcian, von Koch model, Cesaro model, hydrostatic pressure, Hausdorff dimension, Choquet integral.

References

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