A stochastic resonance mechanism for the formation of banded patterns in limestone-marl sequences

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The origin of banded sequences in calcareous-marl deposits is not yet completely understood. In general, both systematic external variations in the environment and self-organized recurrent patterns due to the nonlinearity of the diagenetic processes can generate the sequences, as suggested by cellular automata modelling approaches [1]. In this contribution, a simple diagenetic reactive-transport model (RTM) is presented, following the conceptual model presented in [2]. This RTM differs from the model of [1] by explicitly considering diffusion of dissolved calcium and carbonate ions. However, no self-organized diagenetic oscillations were found in the RTM. Nevertheless, the system exhibits multistability, whereby different steady-state conditions are reached according to the choice of initial conditions. We then simulate the effect of the external environment by subjecting the system to a weak periodic forcing and a random signal. The system then shows stochastic resonance [3], whereby it undergoes noise-induced transitions from one state to another in synchronicity with the periodic external signal, even though the latter is not sufficiently strong to induce such transitions on its own. Consequently, I show how a small periodic variation in the external conditions superposed with a random component triggers substantial transitions between a limestone-rich state and a marl state.

[1] Westphal, Böhm & Bornholdt (2004), *Facies* **50**, 3-11. [2] Munnecke, Westphal, Elrick & Reijmer (2001), *Int. J. Earth Sciences* **90**, 795-812. [3] Gammaitoni, Hänggi, Jung & Marchesoni (1998), *Rev. Mod. Phys.* **70**, 223-287.