Edge of chaos domain of Zhabotinskii CNN: Implications in hydrothermal ore-forming processes

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In describing the dynamics of the complicated Belousov-Zhabotinsky reaction, Zhabotinskii proposed an axiomatic model [1]:

\[
\begin{align*}
\frac{\partial \theta}{\partial t} & = D_1 \Delta \theta \left[1 - \eta \left[2(\theta - 1)^{3}\right]\right] + B \\
\frac{\partial \eta}{\partial t} & = D_2 \Delta \eta - A \eta - \theta(\eta - 1)
\end{align*}
\]

where \( \theta \) and \( \eta \) are concentrations of the components, \( A \) and \( B \) are constant coefficients, \( D_1 \) and \( D_2 \) are diffusion coefficients.

In this paper, the model was mapped into a cellular nonlinear network (CNN) named as Zhabotinskii CNN and the local activity and edge of chaos domains were calculated according to the theory and method described in [2]. The complete procedure and detailed conclusions can be found in [3].

Given practical initial and boundary conditions, choosing the system parameters \( A \) and \( B \) in the edge of chaos domain, we simulated meaningful patterns, some of which can be found in [3]. These patterns formed in the self-organization processes could be good supports to the idea that the onset of large hydrothermal deposits are at the edge of chaos [4]. The calculated edge of chaos domain could also be valuable for large hydrothermal deposits are at the edge of chaos [4]. The processes could be good supports to the idea that the onset of ore-formation.

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References:


Sampling challenges in Re-Os geochronology of black shale

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Re-Os geochronology for black shales is successful for documenting depositional ages and palaeoenvironmental changes. Re and Os are susceptible to post-depositional processes; thus, a sampling strategy grounded in geologic understanding is essential. Here we present Re-Os analyses of Triassic black shales from Svalbard outcrops and Svalis Dome (Barents shelf) drill core [1] to evaluate the effects of water leaching and spatial heterogeneity on Re-Os systematics.

Svalbard shales were leached 3 times, 30 min each, with MQ-H2O in an ultrasonic bath. Each leachate was collected and dried. For these well-indurated, carbonate-cemented shales, leaching removed only 0.2-0.4 wt%. The unleached shales, leached shales, and leachate, however, all have different \(^{187}\text{Re}/^{188}\text{Os} \) and \(^{187}\text{Os}/^{188}\text{Os} \). Svalis Dome shales are poorly indurated, and leaching removed a significant amount of material. Again, the leached and unleached shales have different Re-Os compositions. These tests indicate that water leaching in natural settings (e.g. groundwater flushing or subaqueous outcrops) can disturb the Re-Os system.

It has been proposed that large homogenized samples of black shale (>20g [2]) are necessary to avoid any small scale Re-Os decoupling. For indurated Svalbard shales, <1g samples yield only minor differences in isochron statistics. Re-Os analyses of <1g samples from Svalis Dome, in contrast, fall off the isochron defined by large samples (>20g). Other Re-Os studies using 5g to <0.5g samples lead to excellent isochrons (e.g. Late Permian shale from the Mid-Norwegian Shelf [3], Archean shale from the Superior Province [4]). Homogenizing large samples (~100g [5]) can unnecessarily limit \(^{187}\text{Re}/^{188}\text{Os} \) variations, producing large age uncertainties.

Our results suggest that black shales exposed to surface waters or groundwater flushing should be avoided [6]. The best sample size to secure ‘closed system’ isochrons depends on the age and induration of the black shale, and must be determined independently for each geologic environment.

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