Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12452

New Insights into Geodynamic Processes and Accumulation of Mineral Deposits from UNESCO World Heritage Sites in the Harz and its Ore Mine

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Geological systems in the earth's crust, including orebodies, commonly display rhythmic patterns such as banded formations, layered and folded structures, diapirs and cockade ores that can range from just the micron-, and even sub-micron-scale, to several kilometres. The phenomenon has been examined from a thermochemical-mechanical perspective for a long time. Here, the concept of self-organisation is applied to mineral deposits and geological processes in general. Recognising geological systems, mineral deposits, and orebodies as ordered structures implies that they are considered as systems in which their components and properties are distributed in space and time, providing fundamental aspects to understand them. The description of connections and feedback between contributing key processes is therefore less complex and clearer, leading to an improved understanding and achievable numerical simulations.

The proof of concept was validated by the examination of a recent, early diagenetic banded iron-manganese mud in an abandoned underground mine that had accumulated over 40 years. Two years of in-situ testing revealed that the self-organising nature of the precipitated material was not only caused by fluctuations but also by interaction with redox, colloid, microbial, electrical, and Ostwald-ripening processes. A genetic model for the banded mineralisation was developed and successfully verified by numerical simulation. Moreover, gradients, such as concentration gradients, electric fields, and the like, as well as temperature and pressure, enabled a coupling of the ongoing processes that is spatially and temporally far-reaching. Such thinking could allow other information about geological and ore-forming processes, which is otherwise hidden by time, environmental conditions or by location, to be revealed.

Here, the concept is applied to the “richest” ore of Rammelsberg and the carbonate-rich iron ore of the Oberharz diabase-lineament. An overview of the geological setting at the large-scale and ore types at the local scale will be given, along with findings of the so-called Jacob-experiment. As an ore forming factor the Jacob-experiment uses electric potentials, with which volcanic activity is commonly paired.