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Understanding Minerals Deposits and Ore Forming Processes - The Self-Organisation Concept and its Importance to the Search for New Mineral Resources

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Mineral deposits and ores bodies in the Earth's crust often are showing rhythmic patters as banded formations, layered and folded structures, diapirs or cockade ores. They range in size from less than centimetres up to kilometres. As a part of an overall formation they are open to interaction with their environment.

It is suggested to apply the concept of Self-Organisation to mineral deposits research, see Jacob, Krug, Dietrich [1]. The recognition of mineral deposits and ore bodies as ordered structures allows us to consider them as a system with spatial and time dependent distribution of its components as well as its properties. This is fundamental to the understanding of mineral deposits and ore genesis.

Figure 1: Radiolarian cherts, Ras al Hadd, Oman

Importantly, the control parameters, such as energy or material supply, influence the system at the level of its components and properties. The components in turn interact as a network, constantly adapting the relations to each other. Due to its inner determination, the interactions and relations of the system components shape a self-organising system as one unit. The units show properties of new quality, being completely different from those of its components. The order parameters of the self-organised units are macroscopic descriptors, like the patterns as named above. Their dynamics is of lower dimension than the dynamics of the control parameters, diversity and complexity to be examined are reduced. Hence, macroscopic ordered structures are easier to understand and may be a useful tool in the search for new mineral deposits.

To prove the concept with respect to mineral deposits and ore forming processes, we studied in situ a recent early-diagenetic banded iron-manganese mud in an abandoned underground mine. The precipitation accumulated during a short period of 40 years. The results of 2 years of examination show, that the precipitated material undergoes internal self-organisation due to the interaction of redox, colloid chemical, microbial, electrical and ripening processes, and is not exclusively generated by seasonal fluctuations. It revealed that primary banding of the precipitated material, controlled by external fluctuations, turned into the finally observed bands by

non-linear coupling of reaction and transport processes within the mud. A genetic model for the banded mineralisation was developed and successfully verified by numerical simulation, Dietrich and Jacob [2] and [3].

References:

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[2] Dietrich S and Jacob K-H (1996) Geol Rundsch 85: 29-37
[3] Jacob K-H and Dietrich S (1998) Natural Resources and Development 47: 56-70