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Mechanisms of crystal growth of hydrothermal gold-bearing pyrite

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Pyrite is one of the most common ore minerals in hydrothermal ores and a hallmark of many types of hydrothermal deposits, for example mesothermal quartz veins with pyrite, arsenopyrite, and visible or invisible gold. In addition to any other mineralogical exploration it is possible to examine and interpret the crystal size distribution (CSD) of the mineral which is under investigation. The conditions of mineral-forming processes can be diverse in terms of temperature, pressure, and compositional variables, but the CSD shapes are usually convergent and the by far the most common CSD type is the lognormal distribution [1] [2]. In this study, we determined the CSD from pyrite crystals from the Nízke Tatry Mountains (Western Carpathians, Slovakia). A large number of crystals from ore sections or from electron microscope images were measured manually. All samples show a relatively homogeneous crystal size spectrum from $\approx$2 μm up to $\approx$550 μm. We found out that all CSD's present a lognormal or pseudo-lognormal shape with low logarithmic size variances (β^2). In order to understand the history of nucleation and growth of pyrite formed in hydrothermal milieus we compared our measurements to simulations with different growth mechanisms using the GALOPER (Growth According to the Law of Proportionate Effect) program [1]. From the shape of the distributions, the logarithmic mean (α) and β^2, we inferred that the crystals grew in an open system with its associated growth mechanisms (surface-controlled growth and supply-controlled growth). We are confident that the growth system was open, because we do not see any evidence for ripening-processes in our measurement data or in the numerical simulations of our data. Because we preclude ripening as a growth mechanism, we have to assume that the growth of the pyrite crystals and so the formation of the whole ore body occurred on a relatively short geological time scale. This preliminary result opens more questions related to the emplacement, circulation, and supersaturation of hydrothermal fluids, and to the formation of large ore bodies in short time.

[1] Eberl, D.D., Drits, V.A., and Środoń, J., 1998: Deducing growth mechanisms for minerals from the shapes of crystal size distributions. American Journal of Science, 298:499-533.

[2] Randolph, A.D., and Larson, M.A., 1988: Theory of particulate processes, second edition 369 p. Academic Press, New York.