Genesis of filamentary pyrite associated with calcite crystals

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Abstract: The calcite of the hydrothermal Surneshko Kladenche copper vein deposit from the Rossen ore field, Bulgaria, sometimes encloses peculiar filamentary pyrite crystals. Three successive calcite generations were observed belonging to a low-temperature (<235°C) carbonate paragenesis formed in open cavities of the ore veins after the main chalcopyrite mineralisation. Three generations of pyrite crystals are associated with these calcite crystals: pyrite 1, with [001] elongated columnar crystals which crystallised in open space; pyrite 2, in groups of long (up to 10 mm) sub-parallel tortuous filaments of varying thickness (3-20 µm) which are oriented nearly perpendicular to the surfaces of a transient w{314} scalenohedral calcite crystal zone; and pyrite 3, made of slightly elongated small crystals, located in the outermost v{213} zone of the same scalenohedral calcite crystals. The columnar pyrite 1 is formed by subsequent thickening of thin straight whiskers rapidly grown under diffusional regime, whereas the filamentary pyrite 2 and 3 grew contemporaneously with the enclosing calcite crystal.

Key-words: crystal morphology, filamentary crystals, calcite, filamentary pyrite, contemporaneous growth.

Introduction

Pyrite, the most important and widespread sulphide mineral on the Earth surface, usually occurs in the form of crystals displaying three main equilibrium faces, namely {100}, {111}, and {210} (Sunagawa, 1957, 1987). Nevertheless, many other crystal forms and habits have been reported for pyrite, including skeletal, dendritic and acicular crystals, strongly deviating from the equilibrium morphology (Pabst, 1971; Pshenichkin & Korobeinikov, 1974; Strunz, 1976; Endo, 1978, etc.). White (1973) and Bideaux (1970) described whisker (hairlike), filiform, and even ring-like pyrite formations. Some rare thin pyrite needles formed inside small vesicles have the characteristics of straight or kinked whiskers (Kamb & Oke, 1960; Roberts et al., 1974). A review on pyrite filiform crystals with right-angle bends from different deposits was given by Henderson & Francis (1989). They show that the bending is a specific growth feature of these crystals, not a result of (110) twinning. Bonev et al. (1985) provided a systematic scanning electron microscopic (SEM) and high voltage electron microscopic (HVEM) study on pyrite whiskers and thin platelets from lead-zinc deposits in Bulgaria and discussed their growth mechanisms.

Syngenetic whisker inclusions of pyrite in quartz from Mangyshlak in Kazakhstan were investigated by Galuskin & Winiarski (1997). Zhabin (1986) described filamentary cinnabar inclusions in calcite. Examples of simultaneous growth of two minerals have been reviewed by Grigoriev & Zhabin (1975) (mostly from Russian literature), including inclusions of hematite in quartz (Laemmlein, 1973), cassiterite in fluorite (Lyakhov, 1966), etc.

We studied the formation of pyrite filamentary inclusions in large calcite crystals collected from the Surneshko Kladenche vein copper deposit in the central part of the Rossen ore field, Bulgaria. The pyrite inclusions were isolated by selective dissolution of the calcite matrix, and examined by optical and scanning electron microscopy. The results of these observations are reported in the present paper, followed by a discussion of the growth mechanisms.

Geological setting

The economically important Bourgas ore district is located in the easternmost part of the Cretaceous Srednogorie metamorphic zone. It is comprised of three important ore fields namely, Rossen, Vurly Bryag and Zidarovo. The Rossen ore field is related to the Sonenian Rossen volcanic-intrusive structure of andesites and tuffs in which a central gabbro-monzonite-syenite plutonic core is intruded, followed by porphyritic subvolcanic bodies and dykes (Bogdanov, 1978). The numerous copper ore veins were intensively worked during 1945-1995 in several underground mines.