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Electron backscatter diffraction analysis and implications of replacement microtextures among pyrrhotite, marcasite, and pyrite from the Chiufen-Wutanshan epithermal gold deposits, northern Taiwan

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An ore specimen of 4C pyrrhotite veined with reticulate siderite veinlets associated with minor calcite, chalcopyrite, galena, and sphalerite from the Chiufen-Wutanshan epithermal gold deposits, northern Taiwan was investigated by electron backscatter diffraction techniques and backscattered electron imaging coupled with X-ray energy-dispersive spectroscopy. The result suggests that the pyrrhotite is mantled by randomly oriented pyrite crystals in the periphery of siderite veins and has polysynthetic twinning on $\{102\}$ indexed with a hexagonal lattice of a = 3.516 Å and c = 5.714 Å. Separate irregular grains of marcasite that restrictedly occur within aggregates of pyrite crystals are crystallographically oriented (indexed on the basis of a = 3.37 Å, b = 4.44 Å, and c = 5.39 Å) with respect to specific lattice planes of the nearby pyrrhotite crystals. In some cases, the marcasite has a boomerang-like microtexture with two wings symmetrically distributed across the extension of the $\{102\}$ twinning plane of pyrrhotite. A dominant crystallographic relationship of $\{100\}_{Po} \ || \ \{001\}_{Mrc}$, $\{110\}_{Po} \ || \ \{100\}_{Mrc}$, and $\{001\}_{Po} \ || \ \{010\}_{Mrc}$ and a less distinct relationship of $\{100\}_{Po} \ || \ \{100\}_{Mrc}$, $\{110\}_{Po} \ || \ \{010\}_{Mrc}$, and $\{001\}_{Po} \ || \ \{010\}_{Mrc}$ are present between the pyrrhotite and marcasite.

The data collectively suggest an early topotaxial growth of marcasite on twinned 4C pyrrhotite followed by pyrite replacement for marcasite in association with the penetration of siderite veins. The microtextural sequence implies that the Chiufen-Wutanshan epithermal gold deposits have experienced three stages of mineralogical changes, including (1) the formation of pyrrhotite in a relatively reduced condition at relatively low sulfur fugacities, (2) the reaction from pyrrhotite to marcasite due to the infiltration of a relatively oxidizing ore-forming fluid with a relatively high sulfur fugacity possibly at pH < 5, and (3) the pyrite replacement for marcasite at relatively high pH conditions, possibly through the incursion of meteoric waters.