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Growth Patterns of Pyrite Crystals Studied by Electron Back Scatter Diffraction (EBSD)

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Abstract : Natural formed pyrites (FeS2) are frequent sulfides in sedimentary and metamorphic rocks. Growth textures of idiomorphic pyrite assemblages reflect the conditions during their formation in the geologic sequence, furtheron the local texture analyses of the growth patterns of pyrite assemblages by EBSD reveal the possibility to resolve the growth conditions during the formation of pyrite at the micron scale. The spatial resolution of local texture measurements in the Scanning Electron Microscope used can be in the nanomete scale. Orientation contrasts resulting from domains of smaller misorientations within larger pyrite crystals can be resolved as well. The electron optical studies have been carried out in a Field-Emission Scanning Electron Microscope (FEI Quanta 200) equipped with a CCD camera to study the orientation contrasts along the surfaces of pyrite. Idiomorphic cubic single crystals of pyrite, polycrystalline assemblages of pyrite, spherically grown spheres of pyrite as well as pyrite-bearing ammonites have been studied by EBSD in the Scanning Electron Microscope. Samples were chosen to show no or minor secondary deformation and an idiomorphic 3D crystal habit, so the local textures of pyrite result mainly from growth and minor from deformation. The samples studied derived from Navajun (Spain), Chalchidiki (Greece), Thüringen (Germany) and Unterkliem (Austria). Chemical analyses by EDAX show pyrite with minor inhomogeneities e.g., single crystals of galena and chalcopyrite along the grain boundaries of larger pyrite crystals. Intergrowth between marcasite and pyrite can be detected in one sample. Pyrite may form intense growth twinning lamellae on {011}. Twinning, e.g., contact twinning is abundant within the crystals studied and the individual twinning lamellaes can be resolved by EBSD. The ammonites studied show a replacement of the shale by newly formed pyrite resulting in an intense intergrowth of calcite and pyrite. EBSD measurements indicate a polycrystalline microfabric of both minerals, still reflecting primary surface structures of the ammonites e.g, the Septen. Discs of pyrite (“pyrite dollar”) as well as pyrite framboids show growth patterns comprising a typical microfabric. EBSD studies reveal an equigranular matrix in the inner part of the discs of pyrite and a fiber growth with larger misorientations in the outer regions between the individual segments. This typical microfabric derived from a formation of pyrite crystals starting at a higher nucleation rate and followed by directional crystal growth. EBSD studies show, that the growth texture of pyrite in the samples studied reveals a correlation between nucleation rate and following growth rate of the pyrites, thus leading to the characteristic crystal habits. Preferential directional growth at lower nucleation rates may lead to the formation of 3D framboids of pyrite. Crystallographic misorientations between the individual fibers are similar. In ammonites studied, primary anisotropies of the substrates like e.g., ammonitic sutures, influence the nucleation, crystal growth and habit of the newly formed pyrites along the surfaces.

Keywords : Electron Back Scatter Diffraction (EBSD), growth pattern, Fe-sulfides (pyrite), texture analyses
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