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Complex fragmentation and silicification structures in fault zones: quartz mineralization and repeated fragmentation along the Fountain Range Fault (Mt. Isa Inlier, Australia)

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In large-scale fault zones fracture networks are commonly generated by high volumes of pressurized fluids, followed by quartz precipitation. In this way large amounts of quartz are formed as microcrystalline masses and as complex vein systems, with partly highly different textures, as a result of different formation processes.
Based on field and microstructural data and the quantification of vein patterns, the spatial and temporal connection between fragmentation, quartz crystallization and fluid and material flow along the Fountain Range Fault at Fountain Springs was investigated. Dextral strike-slip led to up to 25 km horizontal displacement along the fault. Due to various fragmentation and quartz formation processes, a ca. 100 m high, 80 – 100 m wide and km-long quartz ridge with numerous vein systems and variable microfabrics was formed. Locally, lenses of highly altered metamorphic wall-rocks occur in the quartz zone. Where exposed, the contact to wall rocks is sharp. Millimetre- to decimetre-thick quartz veins penetrate the wall-rocks only within metre distance from the contact. Several clearly distinguishable fine-grained reddish, brownish to dark and pigment-rich quartz masses form up to 50 m wide and up to several 100 m long steep lenses that build the major part of the silicified fault zone. A chronology can be established. Some of these lenses are oriented slightly oblique to the general trend of the quartz zone, in agreement with the supposed dextral strike slip along the fault.
Numerous generations of typically μm-cm thick quartz veins transect the microcrystalline quartz masses and, locally, form anisotropic networks. In the quartz masses, angular fragments often composed of quartz with, again, internal fragmentation structures, indicate earlier fracturing and silicification events. Within the veins, quartz forms geodes, locally filled with fine-grained reddish quartz and palisade structures with feathery textures and fluid-inclusion zoning. Millimetre- to rarely up to 10 cm-thick late veins transect the earlier quartz phases. The fine-grained vein filling is dark-reddish. It contains μm-sized quartz and, again, angular quartz fragments.
All these features indicate a multiphase fragmentation and quartz precipitation history of the Fountain Range Fault. Intense fragmentation, together with fluid infiltration and quartz crystallization in pore space, led to fine-grained cataclastic and silicified masses, followed by numerous events of quartz-vein formation and, again, cataclasis probably leading to flow of particle-fluid suspensions. In general, macro- and microstructures reflect the interaction of repeated processes of fragmentation, fluid flux, quartz precipitation and cataclastic flow during the long-lasting history of the fault zone, with probably non-linear behaviour of mechanical and chemical processes.