Quartz recrystallization mechanisms and quartz crystallographic preferred orientations (CPOs) are used to examine the thermo-kinematic evolution of a mylonite zone associated with the extensional Okanagan Valley shear zone in the southern Canadian Cordillera. The north-south striking, <30° west-dipping OVsz forms the southwestern margin of the Shuswap metamorphic complex, which consists of variably mylonitized orthogneiss and paragneiss with transposed leucocratic intrusions over an approximate 1-1.5 km structural section. The ductile fabric is partially overprinted by brittle fracturing and faulting towards the structural top of the shear zone as the footwall was progressively exhumed during Eocene extension. A top-to-the-WNW sense of shear is interpreted from both meso- and micro-shear-sense indicators. Quartz microstructures and quartz c-axis fabric data suggest deformation temperatures progressively increase down from ~280°C to >650 °C over a 1.5 km profile. Quartz a-axis patterns suggest plane strain deformation with slight constriction in the upper 150 m of the structural section. A simplified geometric particle path model demonstrates how penetrative general shear flow along detachment-parallel flow planes in predominantly plane strain deformation could result in significant telescoping of originally horizontal isotherms during progressive exhumation. This model involves a scenario where the focus of deformation migrates up structural section during exhumation, progressively incorporating rocks at lower temperatures as it migrated towards the presently exposed upper margin of the shear zone. Microstructures and CPO fabrics in hotter, structurally lower parts of the shear zone were progressively ‘locked in’ as they were passively exhumed to upper crustal levels.