Public Abstract
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Title:Fluid inclusion evidence for the nature of fluids associated with recrystallization of quartzites in the EJB contact aureole, California

The purpose of this study was to look at the control of fluids and fluid composition on recrystallization of quartzites in the Eureka Valley-Joshua Flat-Beer Creek pluton (EJB), in the White-Inyo Mountains of eastern California. The EJB pluton is a composite pluton of monzodiorite-monzonite-quartz monzonite composition that intruded a Neoprotorozoic and early Cambrian sedimentary shelf sequence, which had previously been metamorphosed to greenschist facies (Nelson et al., 1991). Wall rocks of the contact aureole have vertical to sub-vertical dip and consist primarily of quartzites, marbles, and psammites, and lesser amounts of schists (Morgan and Law, 2004).

The aureole shows varying degrees of recrystallization and deformation. In the aureole on the eastern side of the pluton, the area analyzed in this study, quartzites closest to the contact show the least amount of recrystallization with preserved rounded quartz grains that lack crystallographic preferred orientations (CPO's) (Morgan and Law, 2004). One hypothesis is that low H2O activity prevented recrystallization of quartzite closer to the pluton. A marble unit that lies between the intrusion and the quartzite may have prevented fluid flow from the pluton, keeping the activity of H2O low. Alternatively, the release of CO2 from the marble may also have kept H2O activity low. Farther from the pluton contact, quartzites are moderately to highly recrystallized with few remnant grain shapes and show well-defined CPO's which suggest that a higher activity of H2O allowed recrystallization to take place (Morgan and Law, 2004).

Fluid inclusions were analyzed by microthermometry, laser ablation-inductively coupled plasma-mass spectrometry, and Raman spectoscopy, to define the compositions of fluids that were responsible for the contrasting styles of deformation and recrystallization. All fluid inclusions are secondary or pseudosecondary. The inclusions were grouped into three types based on composition: Type I inclusions are strictly aqueous inclusions with various salts. Type II inclusions are mixed aqueous-carbonic inclusions with an aqueous liquid phase and a vapor bubble with a double meniscus of CO2 fluid and vapor. Type III inclusions have an aqueous-hydrogen sulfide liquid and a single-phase CO2-CH4 vapor.

Type I inclusions are present in all degrees of recrystallization of host quartz, Type III inclusions are found in both moderately and unrecrystallized samples, whereas Type II inclusions are only found in highly recrystallized samples. Salinities vary widely within each degree of recrystallization. Inclusions in highly recrystallized samples have the greatest salinities, in unrecrystallized samples have the lowest salinities, and in moderately recrystallized samples have salinities that span the observed range in all samples.

Isochores were developed using LA-ICP-MS and microthermometry data to determine the trapping environment of the inclusions. The isochores show an extensive range of pressure-temperature conditions of trapping for all types of inclusions, indicating that the pressure-temperature history of the EJB aureole is complex, and that all inclusions appear to have undergone the same complicated history. Previous data on the peak pressure and temperature conditions in the aureole fall into the range produced in this study (Kotney and Dietl, 2002). Na, Ca, K, and Fe were found in significant concentrations, along with Li, B, Mn, Mg, Sr, and Ba in smaller concentrations. Fe and Na are highest in highly recrystallized samples, farthest from the pluton contact, whereas the most Ca occurs in unrecrystallized samples near the pluton-aureole

boundary, likely because of equilibration with the Mule Spring marble during metamorphism.

The more saline CO_2-bearing fluids in the recrystallized quartzite of the outer aureole may be the product of distillation from inclusions trapped during the earlier episode of regional metamorphism, with H_2O infiltrating the quartz crystals and contributing to recrystallization. This study suggests that the fluids trapped in the EJB aureole quartzites are metamorphic from the Antler orogeny, the tectonic event that initially metamorphosed the rocks to greenschist facies (Nelson et al. 1991). Fluid composition has played a role in the recrystallization history of this quartzite. The available H_2O in the outer aureole probably contributed to the wetting of grain boundaries, which allowed extensive recrystallization to take place. It is also probable that the pattern of recrystallization seen in the EJB aureole has strongly been influenced by the amount of strain taken up by the Mule Spring marble, allowing the samples in the inner aureole to be unaffected by the pluton intrusion. There are no units as easily deformable as the Mule Spring in the outer aureole, leaving the quartzite to absorb the strain through significant shortening and recrystallization. Additionally, the higher Ca concentrations in fluids in the inner aureole may have retarded recrystallization of quartzite in the inner aureole.