

Chemical and Physical changes within the damage and pulverized zones of the Mojave segment of the San Andreas fault: implications for the origin of pink potassium feldspar grains

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Abstract

We mapped a tabular zone of pink potassium feldspar alteration in granitic rocks within the damage zone and fault core of the San Andreas fault from Arrowhead Springs to Gorman in southern California. Pink alteration of K-spar, which here is spatially associated with the active trace of the fault, is commonly attributed to metasomatism. To better understand the processes leading to this alteration, we studied two transects perpendicular to the trace of the fault with different structural histories near Littlerock and Lake Hughes, California in order to compare alteration signals. Lake Hughes is on a portion of the San Andreas that has been active throughout much of the faults history while Littlerock is on a relatively young strand that was once a part of an extensional step over. Furthermore, Littlerock exhibits large amounts of pulverization while Lake Hughes contains relatively little pulverization adjacent to the fault core. We collected samples from three distinct zones along each transect; parent rock, damage zone, and pulverized zone. The samples were analyzed for bulk and grain density in order to calculate porosity; XRF was used to determine chemical composition in order to calculate volumetric strain, bulk mass change, and elemental mass change; thin sections were made in order to study textures and microstructures; and select samples were analyzed for particle size distribution. The results of our study indicate that mechanical damage processes dominate in both transects. The pink K-feldspar is interpreted to result from an increase in volumetric strain due to an increase in fracture density and porosity, which then acts as a conduit for fluid migration within the fault zone. Fluids within

intra-granular fractures oxidize iron inclusions commonly found within K-feldspar crystal structure resulting in the pink coloration. The fracturing and fluid migration within the fault zone appears to be cyclic as indicated by the numerous open, healed, and infilled cracks with crosscutting relationships. The two transects differ slightly in their chemical alteration signal. Littlerock experienced a bulk mass increase of about 10% in the damage zone and 12% in the pulverized zone due to elemental mass changes, while Lake Hughes has no bulk mass change and relatively little elemental mass change. Both sites contain dislocation and dissolution features within feldspars and quartz, however, at Littlerock this increases within the damage zone and at Lake Hughes the features are seen within the wall rock and only increase slightly within the damage zone. Both sites contain plagioclase which has been altered to sericite, and at Littlerock, some has been altered to laumontite. However, at Lake Hughes, sericite is also present within the wall rock samples. At Littlerock biotite is being altered to chlorite, while at Lake Hughes the wall rock contains chlorite and biotite which have been altered to clay. Some of the observed mineral alteration products are generally associated with elevated temperatures. The pink alteration at both sites is a clear indicator of sub-grain fracturing and fluid migration due to an overprint of mechanical deformation associated with the San Andreas fault. It appears that Littlerock was also exposed to thermal fluids possibly due to its history as an extensional basin whereas Lake Hughes contains a regional metamorphic signal that is not associated with the fault.