Variations with Shearing Rate in the Mineral Chemistry and Textures of the Two Actively Creeping Fault Traces at SAFOD

D.E. MOORE[1]*

[1]U.S. Geological Survey, Menlo Park, CA 94025
(*correspondence: dmoore@usgs.gov)

The San Andreas Fault Observatory at Depth (SAFOD) deep drillhole, located 14 km northwest of Parkfield, CA, crosses the central creeping section of the San Andreas Fault where measured creep rates are ~25 mm/yr. Coring at 2.65-2.70 km vertical depth (~112°C) successfully sampled the two zones of foliated gouge where creep is localized: the 2.6-m-wide central deforming zone (CDZ) and the 1.6-m-wide southwest deforming zone (SDZ). Whereas most of the recovered core consists of quartzofeldspathic crustal rocks, whole-rock (XRF) compositions of the two creeping traces indicate that they are dominantly of ultramafic origin [1]. The gouge zones consist of porphyroclasts of serpentinite and sedimentary rock dispersed in a foliated matrix of Mg-rich clay minerals, and they are interpreted to be the product of shear-enhanced metasomatic reactions between the wall rocks and serpentinite that was tectonically entrained in the fault [2]. The CDZ takes up the majority of the creep, and it exhibits some differences in texture and mineralogy from the SDZ that is attributed to its higher shearing rate. In addition, a ~0.2-m-wide sector of the CDZ located at its northeastern margin (NE-CDZ) is identical in texture and Mg-clay chemistry to the SDZ, possibly due to a gradient in creep rate across the CDZ. The SDZ and NE-CDZ core samples contain larger proportions and sizes of porphyroclasts than the majority of the CDZ, consistent with a lesser degree of shear-enhanced clay-forming reactions. The SDZ and NE-CDZ also contain pressure shadows and veinlets of calcite that were not seen elsewhere in the CDZ. The gouge matrix clays in the SDZ and NE-CDZ consist of saponite (trioctahedral, Mg-rich smectite) and corrensite (1:1 ordered, interstratified saponite-chlorite), whereas the rest of the CDZ contains saponite but no corrensite. Where age relations can be determined, saponite is always younger than corrensite. The temporal differences in clay-mineral compositions may reflect a change in physico-chemical conditions such as a slight decrease in temperature, with clays in the more actively deforming portions adjusting more completely to the new conditions than those in more slowly creeping portions.

[1] Bradbury *et al* (2011) *EPSL* **310**, 131-144 [2] Moore and Rymer (2012) *JSG* **30**, 51-60