Calibrating the onset of weathering in saprock: An initial step

by

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Saprock is that part of the regolith in which more than 20% of the weatherable minerals are chemically or texturally altered. In the Peninsular Ranges of southern California, saprock is a ubiquitous feature of the landscape where remnants of the plutonic bedrock from which it was derived are preserved as corestones beneath the land surface, or as tors extending above it. Though the timing of formation of saprock is problematical, published rock-varnish microlaminations and cosmogenic ^{36}Cl studies suggest that it may, at least locally, be older than 10,500 years and in some cases older than 21,000 years. Hence, it may have originated during the Pleistocene. If so, then temperatures were likely cooler and precipitation was likely much greater during its early formative years.

At a site located near Japatul (N32°45'39.89" latitude, W116°40'47.14" longitude), I collected from a single corestone, 4 samples, and from the enclosing saprock 3 large blocks. Thin section observations indicate that the tonalite is comprised of plagioclase, quartz, biotite, and hornblende. Notable is the absence of K-feldspar.

Each collected sample was analyzed for its major element chemistry, and bulk and grain density. Using non-central principal component analysis, a linear compositional trend was calculated from p(A)-p(CN)-p(K) compositions derived from the analyzed saprock and corestone samples. In p(A)-p(CN)-p(K) space, the resulting trend extends from the geometric mean of the corestone samples upward through the cluster of saprock samples and then towards the p(A) apex. Principal component 1 explains 94% of the variability of the plotted samples about the linear compositional trend.

I then calculated the scale invariant weathering intensity factor, t_i for each saprock sample, $\mathbf{x}_i$, by orthogonal projection onto the calculated linear trend. For this projection, I used the inner product $t_i = \langle \boldsymbol{x}_i \oplus \boldsymbol{a}^{-1}, \boldsymbol{p} \rangle_a$, where **a** is the geometric mean of the corestone samples, and **p** is the perturbation vector derived from the eigen vectors for principal component 1. The average and 95% confidence interval for the *t* values derived from the saprock samples is 0.12 ± 0.04.

The orientation of the linear compositional trend suggests that the production of the saprock from the corestone involved the loss of Ca, Na, and K in approximately equal amounts. In order to test this interpretation I utilized mass balance arguments, and calculated the changes in elemental mass with Al as the framework element. The results of this part of my study indicated that 14 ± 9% of the mass of Ca, 15 ± 2% of the mass of Na, and 14 +10/-9% of the mass of K was lost during the conversion of corestone to saprock. Such observations imply that at the study site plagioclase and biotite (the only mineral in the tonalite containing appreciable K) are weathering at similar rates. In short, in the Peninsular Ranges of southern California, *t*-values of ~0.1 may indicate that within the regolith fluids have become sufficiently acidic to leach and remove Ca, Na, and K. Work discussed here thus represents the initial step in calibrating the scale invariant weathering intensity factor, *t*, for tonalitic plutonic rocks in the Peninsular Ranges. Clearly, much work remains to be done.