Chemical Alteration of Granodioritic – Tonalitic Saprock and Mixed Plutoniclastic/Metamorphiclastic Alluvium: Exploring the Use of Sieving to Enhance Compositional Linear Trends

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ABSTRACT

The Peninsular Ranges, southern California, USA, commonly contain eroded sections of regolith composed of (1) saprock enclosing corestone or (2) alluvial deposits overlying plutonic/metamorphic basement. In this paper, we present two case studies that focus on evaluating the chemical weathering patterns and statistical properties of compositional linear trends at two adjacent sites characteristic of each of the above two types of regolith. Site 1 is typical of regolith type (1) while site 2 is representative of type (2). In an attempt to enhance the coverage of altered samples about calculated compositional linear trends, < 45 μm fractions were separated from saprock and soil samples and were chemically analyzed.

In p(A), p(CN), and p(K) space, saprock samples from site 1 plot about a linear compositional trend directed away from the p(K) apex. Using orthogonal projection, the average weathering intensity value, *t*, of the bulk saprock samples is 0.09 (± 0.04). When the sieved <45 μm fractions are considered along with the bulk saprock samples, a similar linear compositional trend is calculated. Notably, along the calculated compositional linear trend, sieved fractions plot closer to the A-CN join, and have an average *t*-value of 0.89 (±0.04). Hence, inclusion of the sieved fraction extended the coverage of altered samples about the weathering trend.

Using Na as a reference frame, a statistically significant loss of 10% (+9/-8%) and 14% (+6/-5%) K and P mass, respectively, occurred during the development of saprock at site 1. The loss of K mass is attributed to the alteration of biotite to vermiculite and mixed-layer

biotite/vermiculite, while the loss of P mass is due to the dissolution of apatite. In addition, statistically significant increases in Si (6% ± 4%) and LOI (56% (+37/-30%)) mass occurred. The increase in Si mass reflects either, or both, illuviation of small amounts of kaolinite to the prominent crack system at site 1, or the addition of pedogenic silica. The results of the above elemental mass changes produced a statistically significant increase in bulk mass of 5% ± 3%.

At site 2, bulk soil samples plot about a linear compositional trend directed away from the p(CN) apex. When the <45 µm soil fractions and the bulk soil samples are considered together, a similar Ca and Na depletion trend is produced. Along the latter trend, the <45 µm fractions plot closer to the A-K join than do bulk samples, and thus extend the coverage of the weathering trend. The average weathering intensity value of bulk soil samples is 0.25 (± 0.10), while the *t* values for the <45 µm soil fractions is 0.3946 and 0.4187.

Using Ti as a reference frame, 23% (+11/-9%) and 22% (+15/-12%) of the mass of Ca and Na respectively were lost during the conversion of alluvium to soil at site 2. Such losses are attributed to the incongruent leaching of Ca and Na from plagioclase. In addition, the combined effects of the conversion of biotite to smectite and kaolinite, and the neoformation of illite from plagioclase, produced an overall statistically significant increase in LOI mass of 88% (+117/-72%). This increase in combination with the loss of Ca and Na mass translates into a statistically insignificant decrease in bulk mass of ~2% (±7%).

The results of our work suggests that the inclusion of <45 µm fraction chemical data can significantly enhance the coverage of calculated linear compositional trends, and could be a useful investigative tool for future studies.