Genesis of Dioctahedral Phyllosilicates During Hydrothermal Alteration of Volcanic Rocks: I. The Golden Cross Epithermal Ore Deposit, New Zealand

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Abstract: To characterize the evolution of dioctahedral interstratified clay minerals in the Golden Cross epithermal deposit, New Zealand, hydrothermally altered volcanic rocks containing the sequence smectite through illite-smectite (I-S) to muscovite were examined by optical microscopy, X-ray diffraction (XRD), scanning electron microscopy (SEM), and transmission and analytical electron microscopies (TEM/AEM).

XRD analyses of 30 oriented clay samples show a broad deposit-wide trend of increasing illite content in I-S with increasing depth and proximity to the central vein system. Six representative samples were selected for SEM/TEM study on the basis of petrographic observations and XRD estimates of I-S interstratification. Ca and Na are the dominant interlayer cations in smectite, but as the proportion of illite layers in I-S increases, so does the K content and (^{IV}Al + ^{VI}Al)/Si ratio. Layers and packets tend to flatten and form larger arrays, reducing the amount of pore space. Smectite coexists with (R = l) I-S, rather than being (R = 0) I-S where R is the Reichweite parameter. The highest alteration rank samples contain discrete packets of mica to ~300 Å thick, but a limited chemical and structural gap exists between illite, which is intermediate in composition between common illite and muscovite, and illite-rich I-S. Selected-area electron diffraction (SAED) patterns of mica show that the 1*M* polytype dominates, rather than the common 2M_1 polytype.

Petrographic, SEM, and TEM data imply that all phyllosilicates formed via neoformation directly from fluids. Relatively mature I-S and micas form simultaneously, without progressing through the series of transformations that are commonly assumed to characterize diagenetic sequences during burial metamorphism in mud-dominated basins. Although the overall distribution of clay minerals is consistent with temperature as a controlling variable, local heterogeneities in the distribution of clay minerals were controlled by water/rock ratio, which varied widely owing to different rock types and fracture control.

Key Words: 1*M* polytype • Dioctahedral Clay Minerals • Epithermal • Hydrothermal Alteration • Illite-Smectite (I-S) • Neoformation • Smectite • Transmission Electron Microscopy (TEM) • Volcanic Rocks

Clays and Clay Minerals; April 2001 v. 49; no. 2; p. 126-140; DOI: 10.1346/CCMN.2001.0490203
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