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# CLAYS and CLAY MINERALS at a glance

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## CATION REPLACEMENT STUDIES ON HETEROIONIC BENTONITIC CLAY FRACTIONS USING SPECIFIC ION GLASS ELECTRODES

**Walter Fertl and F. W. Jessen** 1

Centrifuged fractions ranging in size from 2·0 to 0·05 $\mu$ of a Wyoming bentonite, Bentonita de Durango from Mexico, and Helms clay from Texas were studied. The variation in replacement of $Na^+$, $Ca^{2+}$, $Mg^{2+}$, $K^+$, and $H^+$ from these heteroionic clay systems under specific equilibrium conditions of salt concentrations was measured. The displacement cation distribution was monitored by using specific ion glass electrodes, such as a sodium ion electrode, a cationic glass electrode, a calcium ion electrode, and a Tektite electrode. Coarser fraction sizes of Wyoming bentonite were found to have a larger $Ca^{2+}$ population. Bentonita de Durango of Mexico has almost equal amounts of $Na^+$, $Ca^{2+}$, and $Mg^{2+}$ in the exchange positions whereas Helms clay of Texas is a predominantly $Ca^{2+}$–$Mg^{2+}$ clay in which the amount of exchangeable $Mg^{2+}$ increases with decreasing particle size. Wyoming bentonite indicates an increased rate of $Mg^{2+}$ removal relative to $Ca^{2+}$ at all higher electrolyte concentrations, whereas for Bentonita de Durango both $Ca^{2+}$ and $Mg^{2+}$ exchange patterns indicate a similar rate of exchange. Helms clay showed $Ca^{2+}$ replacement predominant to $Mg^{2+}$, except in the finest fraction. Some applications to drilling and production techniques are suggested.

## HYDROTHERMAL ARGILLATION OF VOLCANIC PIPES IN LIMESTONE IN MEXICO

**W. D. Keller and Robert F. Hanson** 9

Previously reported deposits of kaolin of hydrothermal origin in Mexico have been described from igneous parent rocks dominantly extrusive in occurrence. Recently observed evidence from other localities confirms an intrusive mode of occurrence, however, for hydrothermally kaolinized agglomerate and tuff within limestone host rock. Three such occurrences have been recognized near Jasso-Calera, north of Mexico City, and near Coacoyula, Guerrero, and Sombrerete, Zacatecas. The contacts of these clay deposits with limestone show regularly a concentration of iron-rich minerals such as red to brown oxides and/or nontronite, but less commonly an irregular development of grossularite, and bands or pockets of endellite. Silica gossans indicate that hypogene altering solutions were active into the current geomorphic cycle. Kaolinite at the center of the clay body and endellite at the border zones are interpreted as originating, respectively, from *in situ* alteration of solid rock, and deposition from ambient solutions.

## FORMATION OF HALLOYSITE FROM FELDSPAR: LOW TEMPERATURE, ARTIFICIAL WEATHERING VERSUS NATURAL WEATHERING

**Walter E. Parham** 13

Weathering products formed on surfaces of both potassium and plagioclase feldspar ($An_{70}$), which were continuously leached in a Soxhlet extraction apparatus for 140 days with 7·2 l. of distilled water per day at a temperature of 78°C, are morphologically identical to natural products developed on potassium feldspars weathered under conditions of good drainage in the humid tropics. The new products, which first appear as tiny bumps on the feldspar surface, start to develop mainly at exposed edges but also at apparently random sites on flat cleavage

surfaces. As weathering continues, the bumps grow outward from the feldspar surface to form tapered projections, which then develop into wide-based thin films or sheets. The thin sheets of many projections merge laterally to form one continuous flame-shaped sheet. The sheets formed on potassium feldspars may then roll to form tubes that are inclined at a high angle to the feldspar surface. Etch pits of triangular outline on the artificially weathered potassium feldspars serve as sites for development of continuous, non-rolled, hollow tubes. It is inferred from its morphology that this weathering product is halloysite or its primitive form. The product of naturally weathered potassium feldspars is halloysite $\cdot 4H_2O$. The flame-shaped films or sheets formed on artifically weathered plagioclase feldspar do not develop into hollow tubes, but instead give rise to a platy mineral that is most probably boehmite. These plates form within the flame-shaped films, and with continued weathering are released as the film deteriorates. There is no indication from this experiment that platy pseudohexagonal kaolinite forms from any of these minerals under the initial stage of weathering.

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## POTASSIUM RELEASE FROM MUSCOVITE AS INFLUENCED BY PARTICLE SIZE



Completeness of exchange of K from muscovite by $Ba^{2+}$ ions decreased with particle size below $20\mu$. Accompanying K exchange at 120°C, using a repeated batch technique, was a marked loss of Si and the formation of boehmite in the finer fractions. Several possible explanations for the unexpected high K retention of fine mica fractions are discussed. The formation of a diffusion-inhibiting surface "skin" is discounted, because equilibrium was obtained more rapidly with the fine fractions than with coarser fractions. The average degree of bending of unit mica layers due to peripheral expansion is probably greater in large particles. With bending, rotation of tetrahedra and shifting of adjacent layers with respect to each other may induce greater release of K and a lower selectivity for this ion. Fault planes may induce preferential expansion of individual layers and initiate interstratification and splitting of particles. Splitting of particles may reduce bending and increase K selectivity.

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## ELECTRON MICROSCOPIC IDENTIFICATION OF SINGLE CRYSTALS OF WAIRAKITE, A RARE COMPONENT IN CLAYS



Crystallites of the finest fraction of a clay mineral from Rosamund, California, which account for over 50 per cent of the total weight, are identified as wairakite single crystals of 0·1–1 $\mu$ size. High magnification electron microscopy revealed flat, almost perfectly square-shaped lamellae, which consist of superimposed layers of approximately $< 50$ Å thickness. Electron diffraction patterns from a selected single crystal proved that the basal plane of the crystallite aligned perpendicular to the electron beam is the (111) plane. It is suggested on the basis of the present study and the report of previous investigators that the pseudocubic wairakite crystals cleave along their (111) and ($\bar{1}$11) planes. The indices of high order reflections, unpublished or previously reported as uncertain, are determined.