What is Clay?

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The designation clay includes a particular range of aluminum silicate minerals, meaning that they are composed of compound molecules containing aluminum oxide and silicon dioxide along with other elements. Clay is formed by long-term decomposition of certain crystalline aluminum silicate rocks of the feldspar family or by the decomposition of volcanic ash. Feldspar is an intrusive igneous rock, forming when liquid magma cools very slowly deep underground. In both natural rock and glaze, the slow cooling of a glassy melt from liquid to solid encourages growth of visible crystals of separate component materials. The slower the cooling, the larger the crystals become. Rocks featuring large visible crystals are broken down more readily by natural forces than those with a tight homogenous structure. Such visible crystals are a primary characteristic of feldspathic rocks found in nature. Along with quartz and mica, feldspar is a primary component of granite, among the most common rocks in the earth's crust and one easily weathered because of its coarse crystalline structure. The "batholith" forming the backbone of the Sierra Nevada Range is almost entirely granite.

Except in the case of true natural glass like obsidian, every mineral features a repeating geometric crystalline framework or lattice of atoms and molecules specific to that mineral. The crystalline lattice in some minerals, like quartz, feature equal molecular bonding strength in all directions. Feldspars and clays belong to a subclass of silicate minerals called phyllosilicates characterized by sheet-lattice molecular structure with the greatest bonding strength in two-dimensional planes, and thus these minerals readily divide into thin layers or particles. Mica is a familiar phyllosilicate with a radical sheet-lattice structure easily cleaved into paper-thin sheets.

In chemical composition, feldspar and clay differ in that feldspar contains significant potassium, sodium, calcium, and/or lithium, elements that serve as fluxes or melters in clays and glazes. These fluxes provide integral strength in the original feldspathic rock. Because of the susceptibility of feldspar's crystalline structure, natural metamorphic forces cause it to fracture underground. Over geological time, acidic groundwater and steam pass through the fractures, leaching out most of the fluxes, further breaking down the original structure, which open more pathways into the parent rock. The end product of long-term hydrothermal decomposition of feldspar is kaolinite, the most common clay mineral. The sheet lattice bonding of feldspathic rock loses its structural integrity as the fluxes are lost, and the rock decomposes into masses of submicroscopic, flat, disk like kaolinite crystals called platelets. Kaolinite is the basis of most of the clays mined and used in ceramics. One important exception is bentonite, formed when airborne volcanic ash settles in thick beds and breaks down over geological time into extremely fine platelets, the finest of any naturally occurring clay.

Among the more striking sights of the American deserts are playas, broad white flats covering the bottoms of low desert valleys. Among the most famous are Badwater in Death Valley and

Bonneville Salt Flats in Utah. Playas are the dry beds of lakes with no natural outlet, where storm runoff converges and the water evaporates in the hot, dry climate, leaving thick deposits of clay and silt mixed with alkaline salts. These are the soluble salts of sodium, potassium, calcium, lithium, and other materials leached from rock in the surrounding mountains, providing visible evidence of the slow transformation of feldspar into clay.

For more information, see the handouts, “What Makes Moist Clay Behave as It Does?” and “Green-Packing Density and the Effects of Particle Size on Clay Performance.”