CLAY MINERALS IN THE MORRISON FORMATION ON THE COLORADO PLATEAU

by

W. D. KELLER

U.S. Geological Survey, University of Missouri, Columbia, Missouri

EXTENDED ABSTRACT[1]

The Salt Wash sandstone member of the Morrison formation of Jurassic age has been a major source of uranium on the Colorado Plateau and undoubtedly will continue to be such for many years. The clay minerals of the Morrison formation are being studied as part of the uranium investigations of the Plateau by the U.S. Geological Survey.

The lower part of the Morrison formation consists of the Salt Wash sandstone member and, in the southeast part of the Colorado Plateau, of intertongued correlatives of the Salt Wash, namely the Recapture shale member and part of the Bluff and Cow Springs sandstones. These members of the Morrison range from 0 to approximately 400 ft in thickness. The upper part of the Morrison consists of the Brushy Basin shale member, and to the south and east, of intertongued Westwater Canyon sandstone member and the Jackpile sandstone of local usage. The maximum thickness of the upper unit on the Colorado Plateau is about 450 ft, but increases to 600 ft near Vernal, Utah.

The clay minerals in about 500 samples of variously colored mudstones and sandstones from the Morrison formation were identified chiefly by x-ray diffraction, augmented by differential thermal analysis, chemical analysis, and microscopic examination. The formation was sampled from the San Rafael Swell in Utah to the Thoreau–Laguna region in west-central New Mexico; the collection includes samples from barren as well as uranium-bearing portions of the formation.

The Salt Wash sandstone member contains illite as the most common and abundant clay mineral in both the mudstone and sandstone portions, although chlorite and mixed-layer illite–chlorite are also widely distributed in them. Kaolinite has been developed, probably secondarily, in the sandstones. Montmorillonite is present in a large tongue that pinches out eastward in the lower part of the Salt Wash member in the northwestern part of the Plateau. Except for the volcanic-derived montmorillonite, most of the clay in the Salt Wash member is believed to have a sedimentary-rock origin. The Recapture shale member is characterized by illite in northwestern New Mexico, an abundance of montmorillonite at Thoreau, New Mexico and mixed-layer clay minerals east from Thoreau. These changes are interpreted as facies variations outward from the source area. The Bluff sandstone, which contains only a small amount of clay, yields montmorillonite in the clay-size fraction. The montmorillonite probably originated from small amounts of volcanic ash in the sandstone, but direct proof of its origin is lacking.

In the Brushy Basin shale member, montmorillonite predominates in the northwestern part of the Colorado Plateau, but illite, chlorite and mixed-layer clay minerals increase in abundance toward the south. The latter assemblage of minerals occurs in the Westwater Canyon sandstone member and for that reason the southern part of the Brushy Basin shale member is interpreted as being in part a clay facies of the Westwater Canyon sandstone member. The parent rock of the montmorillonite in the Brushy Basin member was chiefly volcanic material, as is shown by occasional replaced and

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preserved shard structures, incompletely decomposed glass, euhedral mica and associated feldspar grains. The illite- and chlorite-rich portion may be a mixture of volcanic and sedimentary-derived detritus. The clay fraction of the sandstone of the Jackpile is dominantly kaolinite with minor amounts of mixed-layer illite–montmorillonte, but the mudstone of the member is mainly illite–montmorillonite and illite–chlorite.

Color variations in the Brushy Basin rocks aid in distinguishing some clay mineral differences in it. Variegated pastel shades of red, orange, purple, gray and intermediate colors are more commonly found in normal montmorillonite. The vivid green zone at the head of Courthouse Wash in Utah contains illite and high-potassium montmorillonite. The blue mudstone on Lone Tree and Blue Mesas north of Uravan, Colorado contains illite, and the green glauconitic mica near the top of the Brushy Basin shale member on Lone Tree Mesa is high in ferric iron and potassium. Green and blue colors perhaps are exhibited in clay minerals where an element, such as iron, exists in the crystal structure in two states of oxidation (following the observations of Weyl). This situation apparently is most readily realized in the K-rich clay minerals. A source of potassium may be found in the Permian evaporites that have risen in anticlines in Salt, Paradox and Sinbad Valleys, which are near Courthouse Wash and Lone Tree Mesa. The green and blue colors described do not originate from Co, Cr, Cu, Ni or V in the mudstone, as those elements are present in the rocks only to the extent of thousandths of 1 percent and are not significantly different in abundance between blue, green, gray, and red mudstones.

Greenish-gray mudstones, although reported to be more favorable ground for uranium ore deposits than red mudstone, contain the same gross clay mineral assemblages as the red rocks. Thus gross clay mineral composition has not been found to be a guide to uranium ore minerals.

The mudstones on the semi-arid Colorado Plateau provide striking examples that montmorillonite weathers to a "frothy" surface, illite and chlorite go to smooth or "slick surfaces". Perhaps more progress toward field identification of the several clay minerals by such easily recognizable criteria may be made as field observations are further correlated with laboratory identification of clay minerals.