CLAY MINERALS OF THE ECUADORIAN CANGAHUA AS PRODUCTS OF VOLCANIC TUFF WEATHERING

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The Ecuadorian Cangahua is an indurated volcanic formation. For geologists it consists of tuff resulting from induration of ash deposits. For pedologists, this induration could be due to weathering products under a subarid climate. The aim of this paper is to confirm the former tuff formation as well as the play of pedogenesis in the clay formation. Our previous studies (chemistry, petrography, mineralogy, sedimentology) have suggested that the Cangahua originated from pyroclastic flows of dacitic ashes. The deconvolution of grain-size frequency curves (according to Lirer et al., 1996) demonstrates the depositional process. Every pyroclastic event has left a composite deposit including flow and surge deposits, ash falls and hydrovolcanic products. Induration of some layers, early after this deposition, could be due to former hydrothermal alteration of minute glass shards, producing amorphous matrix in the incipient Cangahua. Now, at the bottom of paleosols the Cangahua has a matrix made of various clay minerals, which result from subsequent weathering. Indeed, there is a good relationship between the nature of clay minerals and the present climatic conditions. These minerals are varying with the moisture regime from semiarid to perhumid, according to a toposequence. We observe successively:
– at semi-arid foot-slope, predominant silica-rich clays like beidellite or poorly crystalline 2 : 1 clays and small amounts of opal and calcite.
– at semi-arid mid-slope, abundant halloysite and segregation of iron oxides.
– at perhumid summit, predominance of allophane and occasionally small amount of halloysite.

KAOLINITE CLAYS OF COAL DEPOSITS – INDICATORS OF PALEOGEOGRAPHICAL AND PALEOGEODYNAMICAL CONDITIONS (SOUTHERN URALS)

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Widespread occurrence of kaolinite clays in coal-bearing series of different ages, especially in the Mesozoic–Cenozoic coal basins of the Ural region is well known. Syngenetic formation of kaolinites in the South Ural coal basin is undoubtedly related to destruction of Mesozoic weathering crusts which were formed on the peneplain of the Ural postpaleozoic orogen. Two genetically different types of kaolinite are present here. The first type of kaolinite – terrigenous-sedimentary – is located in undercoal deposits. Its structure is perfect and partially destroyed. It is distinctly visible on X-ray diffractograms. The mixed-layer kaolinite-smectite found here differs by various contents of swelling layers. Such structure of kaolinite shows its eluvial genesis and long transportation as the result of destruction of humid weathering crusts of aluminosilicate rocks. These rocks were widely spread in the Cenozoic in the Southern Urals area. Kaolinite of the second type is authigenic, diagenetic and it is present in the intercoal layers of lake-bog origin. It differs from kaolinite of the first type by perfect structure and directly replaces the first type under productive coal layers and in intercoal layers. Raw materials for formation of this type of kaolinite could be clay products of weathering of ancient magmatic rocks. These clay products formed autigenic kaolinites with accomplished structure from mixed-layer (kaolinite-smectite) terrigenous kaolinites in acid-bog conditions. So-called "tonsteins", which represent thin marker layers, deserve a special attention among kaolinite clays in coal series .They are widespread and are the result of transformation of dispersed volcanic material. For such layers, the presence of good-crystalinity minerals, kaolinite with ordered structure and relics of ash structure are typical. Volcanic ashes – initial material for formation of "tonsteins" could be brought on periphery of the Urals by wind. Sources of the ash material were Eocene volcanoes of Bandy-Turcistan, Badkhisa and the Caucasus. Thus, it is possible that there are several varieties of kaolinite clays, which are clear indicators of paleogeographic conditions (climate and facies) of formation of coal complexes in the Southern Preurals. One can also estimate the influence of stability of geodynamic factors on peculiarity of formation kaolinite clay in coal deposits of the examined region.

ILLITE/SMECTITE IN THREE DIMENSIONS

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Mixed-layered illite/smectite (I/S) has been intensively and extensively studied since the pioneering research of Hower and his collaborators in the 1970s. But most of the X-ray diffraction (XRD) results reported then and since has been limited to the basal or 00l patterns that are obtained from oriented aggregates.
Three-dimensional studies are rare partly because of the difficulty of dealing with interfering reflections from other clay (and non-clay) minerals that are invariably present in most sedimentary rocks. The clay-size fractions of K-bentonites (or metabentonites) are convenient to study because they are commonly monomineralic. Most of the results reported here are based on them. But we must bear in mind that their structural characteristics may differ from those of I/S from shales and other rocks, and indeed, there is some evidence supporting this possibility. I/S diffracts in three dimensions like an assemblage of Nadeau fundamental illite particles because coherence between the particles is broken by turbostratic (general) rotations about the expandable interlayers. This is a fortunate circumstance because it allows an analysis of the illite structural state within the particles – an analysis uncomplicated by three-dimensional diffraction effects between the particles. Evidence for this claim is based on the successful computer simulation of three-dimensional XRD patterns of I/S and the observation that experimental three-dimensional patterns are unaffected by changes in mean d_{001} caused by water and ethylene glycol solvation, and dehydration. The illite layers within fundamental particles from a large collection (100) of K-bentonites show a complete series between somewhat disordered (P0=0.5 where P0= proportion of layers not rotated with respect to the underlying layer) and 1M (P0=1) polytypes. This type of disorder is caused by the special rotations of n.60°. I/S from shales is typically 1Md (P0 near 0.333) or only slightly ordered. There is at present no consensus on the cause for this difference. The rarity of 1M illite in shales, and the common occurrence of the $2M_1$ polytype in slates, suggests that the 2M1 structure can form directly from the 1Md polytype and need not pass through the 1M state. Zvyagin, Drits, Tsipursky, and co-workers reported on the natural occurrences of noncentric (cis-vacant) dioctahedral smectite and illite. They reported that many smectites from bentonites are of the cis-vacant variety, showed calculated XRD patterns for cis-vacant smectite and illite, and derived a set cis-vacant illite atomic coordinates that has proved to remarkably accurate. Work in our laboratory, particularly that of McCarty, disclosed that in our collection of about 100 K-bentonites, the cis-vacant type is as abundant as the well-known trans-vacant type, and that the two are commonly interstratified. Selected representative samples cover the entire range from trans- to cis-vacant. McCarty's studies of Ordovician K-bentonites from the Appalachian basin disclosed a definite pattern of cis-vacant structures to the north and trans-vacant types to the south. Cretaceous K-bentonites from the Rocky mountains have, so far, all proved to contain the cis-vacant variety. Cis-vacant illite has been reported in basal Paleozoic sandstones from the northern and central United States and Lee has noted that cis-vacant illite is dominant along fractures near faults, but that the same fractures more distal to the faults contain the trans-vacant variety. Drits has suggested that smectites in shales tend to be cis-vacant and that burial diagenesis and illitization produce progressive changes to the trans-vacant type. These anecdotal results yield no convincing model for the geological significance of the cis and trans-vacant structures. The data base is too weak for that. But as more studies are published on this subject, a robust genetic model should come into focus that will make the systematics of I/S even more useful than they are now for the reconstruction of ancient geological environments.

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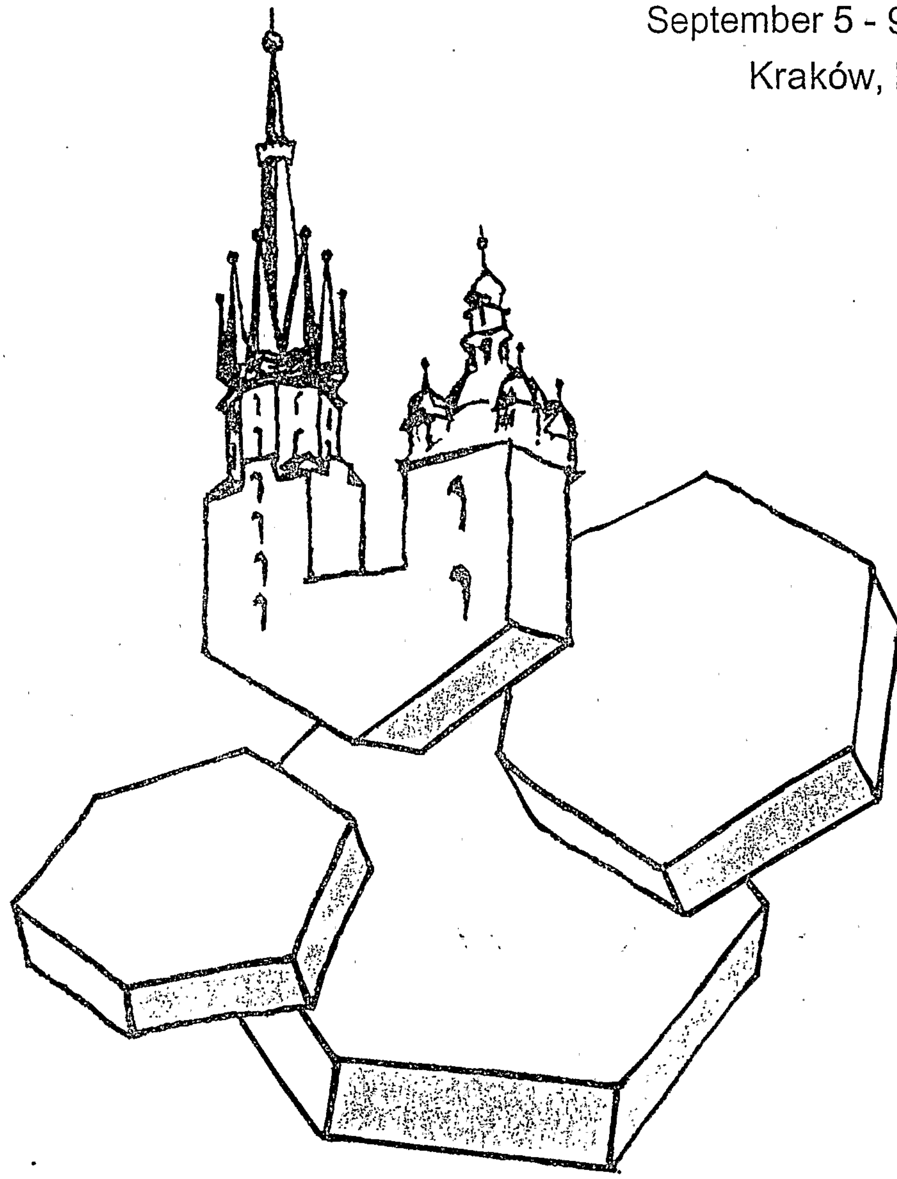

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