IDENTIFICATION OF CLAY MINERALS AND THE STUDY OF ARGILLACEOUS ROCKS BY THE IMBIBO-METRIC METHOD

by

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ABSTRACT

The imbibition of liquid by argillaceous rocks containing predominating kaolinite, illite, "open" illite, and montmorillonite with the use of absorption apparatus is described. Results of the following studies are given: (1) imbibition by pulverized and freely poured samples; (2) imbibition by specimens pressed (30 atm) into the form of small cylinders having a base of 100 mm^2; (3) the course of imbibition by artificial aggregates of kaolin from Sedlec, Bohemia, pressed under different pressures (20, 30, 40 atm); and (4) imbibition by natural, oriented, ground, flat sections of the same samples which were prepared in the form of rectangular prisms, with a base of 100 mm^2.

The constant k in the sorption equation, which is dependent on the form of clay particles and the tortuosity of pores in argillaceous aggregates under particular working conditions, has been computed. This constant has been calculated for water (polar liquid) and tetraline (nonpolar liquid).

A new quantitative diagram for identification of clay minerals by the imbibometric method has been constructed. In it, not only the time of imbibition and the qualitative features expressing themselves on the ground, flat section—such as swelling and nature of contours (Konta, 1961)—are taken into consideration, but also the area occupied by a drop of water and a drop of ethylene glycol and the wettability ratio $P_{egl/aq}$.

INTRODUCTION

This paper is a continuation of the work published by the author (Konta, 1961) under the title "Imbibometry—a new method for investigation of clays". In the work cited the physical principles on which the imbibometric method is based, the working process of the method, and the way the drops of water and ethylene glycol behave on ground flat sections of unconsolidated but coherent argillaceous rocks are explained. The imbibition of suitable liquids by an argillaceous aggregate is regulated by the sorption equation.

The liquid dropped from the pipette from a uniform height above the ground flat sections spreads on the leveled section of a clay which has been cut parallel to the stratification of the rock. The area occupied by the drop on various unconsolidated coherent argillaceous rocks varies according to the wettability of the particular rock, and the amount of wettability in these rocks depends

42

on the mineralogical composition. During imbibometric tests it is necessary to make the following simultaneous observations:

1. Wettability by ethylene glycol (i.e., area occupied by one drop of ethylene glycol); wettability by water (i.e., area occupied by one drop of water).
2. Time of imbibition of one drop of ethylene glycol and one drop of water.
3. Ratio of wettability $P_{egl/aq}$ (computed by dividing the area occupied by a drop of ethylene glycol by the area occupied by a drop of water).
4. Swelling or nonswelling in the case of both liquids (change in the flatness of the surface after imbibition).
5. Presence or absence of characteristic spurs along the periphery of the wetted area.

NEW DIAGRAM FOR THE IDENTIFICATION OF CLAY MINERALS

The chief results observed during the imbibometric tests are the basis for the construction of the diagram (Fig. 1). In the upper part of the diagram the horizontal axis represents the calculated time of imbibition of a drop of water and the vertical axis represents the area occupied by one drop of water. In the lower part of the diagram are the analogous data observed with ethylene glycol. Usually observations are made with a few drops of water and ethylene glycol (at least 2 to 3) and their average values are entered in the diagram. In both parts of the diagram the calculated imbibition time and the average area occupied by water and ethylene glycol are projected as a point. From this point arrows are drawn to indicate the wettability ratio $P_{egl/aq}$. If the wettability ratio is less than 1, the arrow is projected upwards. If this ratio is greater than 1 the arrow is projected downwards. The length of the arrow is proportional to the wettability ratio.

Kaolinite

From the experimental points in both parts of the diagram it can be seen that the drops of water and ethylene glycol are imbibed in a short time by the rocks with predominating kaolinite (nos. 1*, 2, 3, 4). These rocks have very small wettability as indicated by both the polar liquids and it is extremely small in the case of ethylene glycol (see the values on the left part of the diagram). The ratio of wettability $P_{egl/aq}$ in clays in which kaolinite predominates is always less than 1. Also, the drops of both liquids occupy a circular or almost circular area on the ground flat section, having a periphery without spurs. The wetted surface of the section after imbibition remains flat.

Illite

Rocks with predominating illite have experimental points for water (Fig. 1) shifted farthest to the right (nos. 5, 6, 7). In the lower part of the diagram for the imbibition of ethylene glycol experimental points 5, 6, and 7 show a medium speed of imbibition; their wettability with water is almost the same

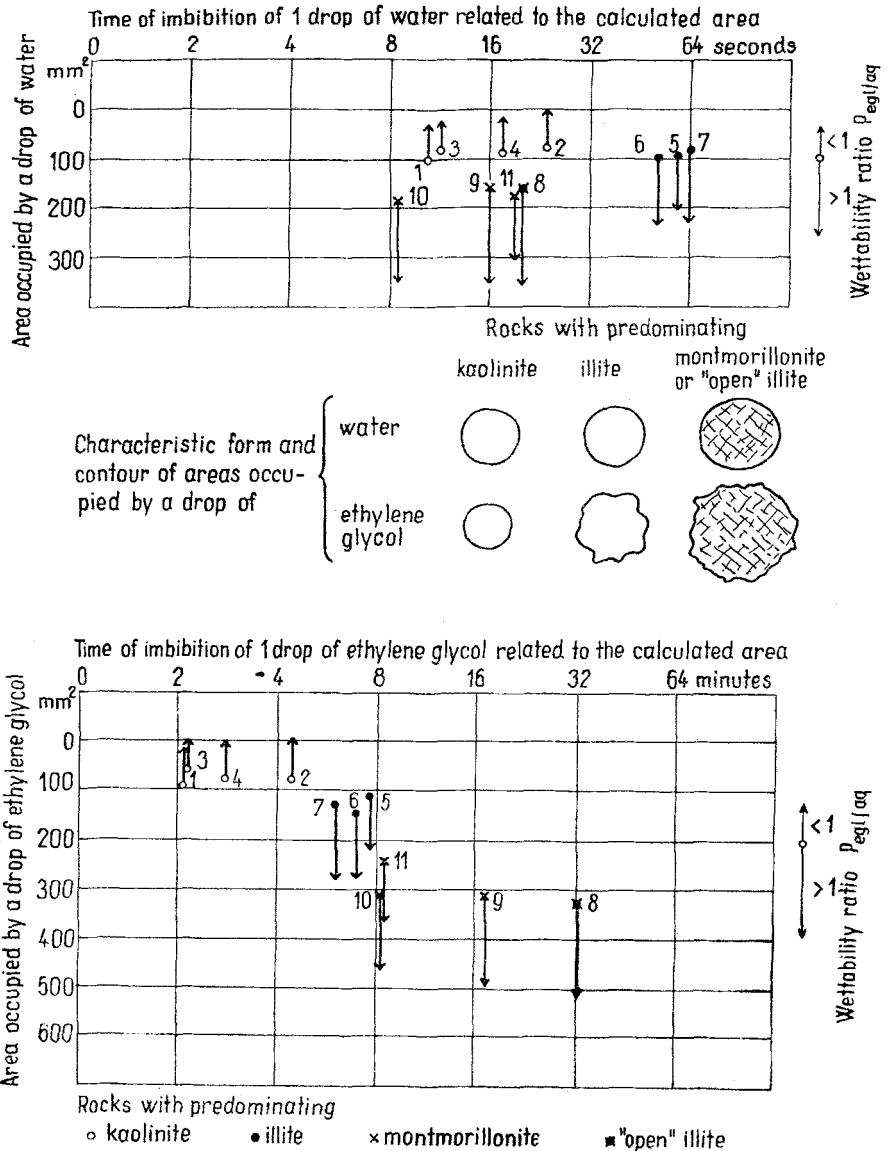* For samples and localities, see Table 1, p. 54

FIGURE 1.—Diagram for identification of clay minerals on ground flat sections of unconsolidated, coherent argillaceous rocks by the imbibometric method.

as in aggregates with predominating kaolinite, or a little higher; wettability with ethylene glycol is essentially greater than in aggregates with predominating kaolinite but less than those rocks with predominating montmorillonite

or "open" illite; and lastly the wettability ratio $P_{egl/aq}$ is always greater than 1 but its average value does not usually reach such values as those of clay with predominating montmorillonite. A drop of water on the ground flat sections of rocks with predominating illite occupies a more or less circular area, sometimes with a few small spurs along the periphery, and a drop of ethylene glycol always occupies a greater area with a larger or smaller number of characteristic spurs along the periphery. The wetted surface after imbibition remains flat.

Montmorillonite and "Open" Illite

Rocks with predominating montmorillonite or "open" (term after van der Marel, 1960) illite which swell (nos. 8, 9, 10, 11) have a very short time of imbibition for a drop of water, and sometimes this time is shorter than for clays with predominating kaolinite. In the identification diagram the experimental points for the imbibition of ethylene glycol by the swelling rocks are shifted farthest to the right. Wettability of these rocks with water, and especially with ethylene glycol, is the greatest in comparison with the aggregates having predominating minerals of the kaolinite group or illite minerals; the wettability ratio $P_{egl/aq}$ for the swelling rocks is always greater than 1. The area occupied by a drop of water on the ground flat sections of rocks with predominating montmorillonite or "open" illite has various forms. Sometimes it is circular; however, the area occupied by a drop of ethylene glycol is large, having many small characteristic spurs along the periphery. The wetted surface of the section after imbibition of water is usually strongly swollen. After imbibition of a drop of ethylene glycol the wetted surface is less swollen; sometimes it is only mat or slightly rough. A very small admixture of montmorillonite or "open" illite will cause a slight swelling or at least cracks on the surface of dry sections when water is used, and also the imbibition time is shortened. This admixture, however, causes a prolongation of the imbibition time of ethylene glycol.

For correct identification of clay minerals, and still more in complex mixtures, during imbibometric tests it is necessary to take into account all-round observations and values which are plotted in the identification diagram.

COURSE OF IMBIBITION OF WATER ON
GROUND FLAT SECTION

Immediately after a drop of a liquid is allowed to fall from the pipette onto the levelled surface of a ground flat section, imbibition starts, as a result of the capillary strength of the argillaceous aggregate. The whole amount of liquid contained in a drop, however, is not imbibed by a definite area during the whole imbibition time. During the early stage of imbibition the liquid moves on the section and the area that is wetted changes to some extent. The drop spreads slowly or quickly into a larger area depending on the wettability of the aggregate. In illitic and particularly montmorillonitic aggregates

the characteristic spurs are developed along the periphery of the wetted area. During imbibition these spurs change their form and size. During the later stage of imbibition the liquid is imbibed by certain portions of the wetted area earlier than by the other portions. The various stages of imbibition of a drop of liquid by kaolinitic clay are shown in Fig. 2, and by montmorillonitic
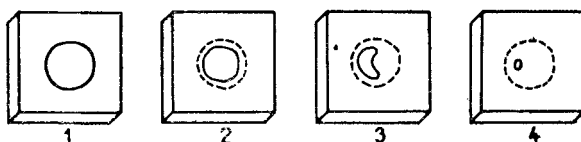

FIGURE 2.—Various stages during imbibition of a drop of water on ground flat section of kaolinitic clay.

clay in Fig. 3. However, a larger part of the liquid is imbibed by the maximum area occupied by the liquid on the section of an argillaceous aggregate. The liquid is imbibed for the longest time by the maximum area on the section occupied by a drop of liquid. The portion below the surface of the wetted area has the form of a shallow dish. It can be assumed that the liquid after complete imbibition by the argillaceous aggregate is distributed uniformly in
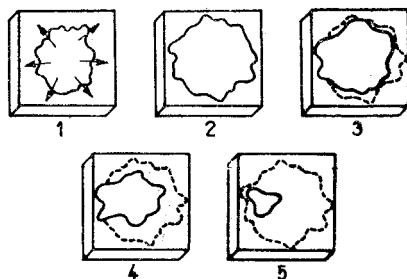

FIGURE 3.—Various stages during imbibition of a drop of ethylene glycol on ground flat section of montmorillonitic clay.

the pores of the wetted aggregate, being influenced by the capillary strength. Results of imbibometric tests using drops from the pipette are mutually comparable and the results can be used for various purposes, particularly for identification of clay minerals. However, for computation of the different factors using the sorption equation, more precise values are necessary. For this purpose the area of imbibition must be constant during the whole period of imbibition. To maintain the constancy of the imbibition area the apparatus constructed after O. Schmidt is found very suitable. This apparatus was first used by Freundlich, Schmidt and Lindau (1932) and later by Freundlich, Enslin and Lindau (1933) for other purposes.

IMBIBITION OF LIQUIDS BY ARGILLACEOUS ROCKS WITH THE AID OF SORPTION APPARATUS

Apparatus Used

The sorption apparatus constructed according to the authors cited above (Fig. 4) has the following parts: a glass U-tube with a funnel N for the liquid at one end and a filtration crucible K on the other end. The U-tube is connected with a pipette P lying horizontally and graduated into divisions of 0.01 mm³. All these parts are interconnected by ground surfaces. In the filtration crucible a glass filtration plate F is so fixed that its bottom surface corresponds in level to the upper border of the horizontal pipette. The graduated pipette (P) is connected with the U-tube by a three-way glass

FIGURE 4.—Sorption apparatus after O. Schmidt.

stopper, T. The prepared clay sample is placed on the filtration glass plate where it gradually absorbs the liquid. The amount of liquid absorbed during a specific time can be read on the pipette with an accuracy of 0.01 mm³ and can be estimated with an accuracy of 0.001 mm³.

Enslin (1933) measured with this apparatus the sorption capacity of pulverized soils for water. This apparatus was much criticized for being defective, particularly in the indefinite form of the cone of the poured pulverized material. Despite criticism this apparatus was used extensively in laboratories for soil science and soil mechanics, for determining the maximum moisture sorption (Feuchtigkeitsaufnahme). Freundlich, Enslin and Lindau (1933), using this apparatus, studied the influence of various sorbed dyes on the speed of imbibition of water by pulverized nonswelling materials, such as quartz, realgar, and galena.

Imbibition of Water by Pulverized and Freely Poured Argillaceous Materials

Imbibition was studied in eleven samples of argillaceous rocks of which four had predominating kaolinite (nos. 1, 2, 3, 4), three had predominating illite (nos. 5, 6, 7), one contained "open" illite as an essential constituent (no. 8) and three had predominating montmorillonite (nos. 9, 10, 11). For this study the same samples were used as those employed for imbibometric investigation with drops from the pipette (Konta, 1961). The samples were

finely pulverized and sieved through a 200 mesh screen. The samples were studied in part under moist laboratory conditions (relative humidity 45 ± 2 percent and temperature $20 \pm 1°$C) and in part dried in a vacuum over anhydrous P_2O_5 for a period of 15 hr. The weight of each sample was 0.2 g. The sample poured on the filtration plate formed an irregular cone.

Figure 5 shows the sequence of sorption of pure water at the temperature of $20 \pm 1°$C by pulverized rocks with predominating kaolinite, illite and
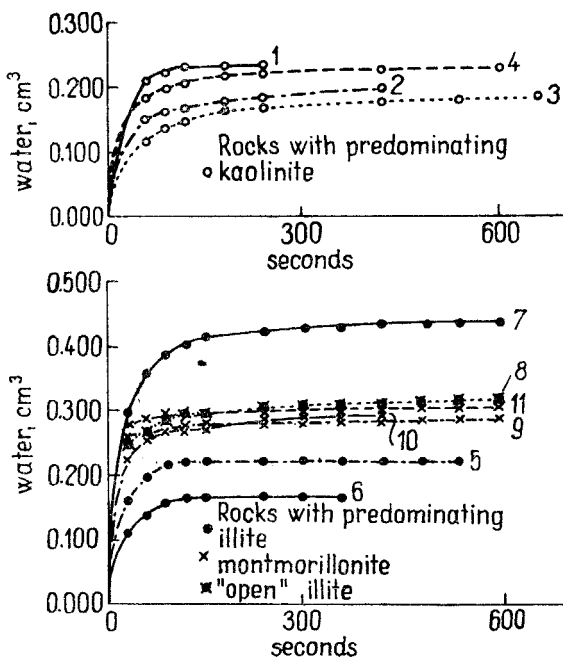

FIGURE 5.—Sequence of water imbibition $(20 \pm 1°$C) by pulverized argillaceous rocks having moisture of laboratory air.

montmorillonite having the laboratory moisture. Figure 6 shows the sequence of water sorption by the same samples previously dried and almost without molecular water. It can be inferred from the diagrams that the differences in the rate and capacity of the sorption between the pulverized argillaceous materials of different mineralogical composition and different moisture content are not so marked in contrast to their marked differences in behavior when they are tested in their natural state. The marked sorption capacity noticed in the sample of illitic clay from Füzérradvány (no. 7) can be explained by the fact that it is the only sample of the eleven samples studied which remained cohesive when submerged under water for a long time though its effective porosity in the natural aggregate was the highest. During pulverization of this sample, relatively coarse fragments are formed and the

powder sieved through 200 mesh behaves during sorption like very fine sand or coarse-grained silt. In addition, the sorption is also partly influenced by the high original effective porosity which remains in the fragments.

The results obtained for the rate and capacity of sorption (Figs. 5, 6) of water in the pulverized freely poured samples show that this method can be used neither for the identification of clay minerals nor for determining any
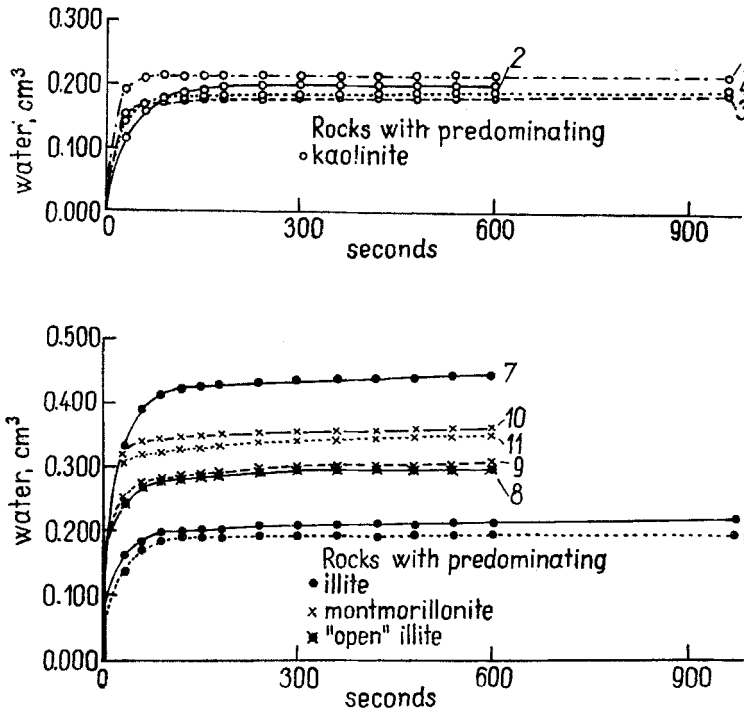

FIGURE 6.—Sequence of water imbibition $(20 \pm 1° C)$ by pulverized argillaceous rocks dried beforehand and almost without molecular water.

physical properties, such as the total surface area. During pulverization of the samples the original capillary system caused by the natural porosity, orientation, form of mineral particles and tortuosity of the pores is destroyed. Free pouring of the pulverized samples gives a new system of pores. During imbibition of the liquid the new capillary system formed by free pouring of the powder predominates over the original capillary system of the argillaceous rocks which remains in the small fragments. Therefore the values of the sorption for the main clay mineral groups determined by this method are not so characteristic as the values determined on natural aggregates.

4

Imbibition of Water by Pulverized and Artificially Pressed (30 *atm*) *Aggregates
of Argillaceous Rocks*

The eleven samples of pulverized argillaceous rocks were sieved through
a 200 mesh screen and pressed in the dry state, under normal laboratory
conditions of temperature and humidity, into small cylinders having a base
area of 100 mm². The pressing was done in a cylindrical hole in a metal block
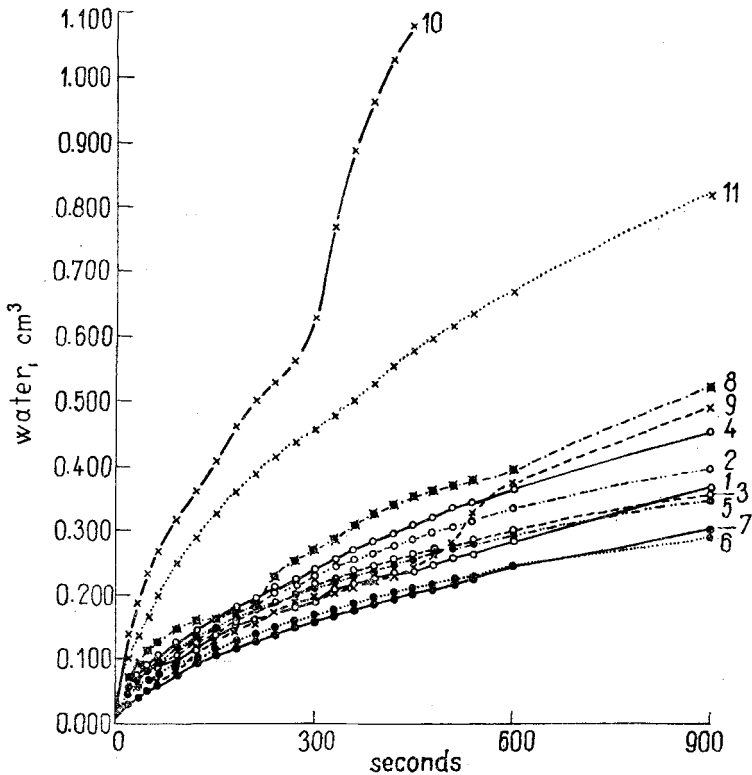by means of a hydraulic press at 30 atm for a duration of 60 sec.

FIGURE 7.—Rate of water (20±1° C) imbibition by artificially pressed aggregates of
eleven argillaceous rocks: 1, 2, 3, 4, with predominating kaolinite; 5, 6, 7, with
predominating illite; 8, with predominating "open" illite; 9, 10, 11, with pre-
dominating montmorillonite (for samples and localities, see Table 1).

Figure 7 shows the speed of water imbibition by artificially pressed
aggregates of eleven argillaceous rocks. The slowest rate of imbibition was
observed in aggregates with predominating illite (nos. 7, 6, 5); a slightly
faster rate of imbibition was noticed in aggregates with predominating
kaolinite (nos. 1, 3, 2, 4); and the fastest rate of imbibition was observed in
aggregates of swelling clays (nos. 8, 9, 10, 11). The rate of imbibition is

indirectly dependent on the total surface area of the particles in the case of nonswelling clays, as apparent from Fig. 7. In rocks with predominating montmorillonite and "open" illite the swelling manifests itself, in contrast to the previous experiments where the pulverized samples were freely poured. The irregularity of sorption curves 8, 9, 10, 11 is caused by pronounced cracking of the pressed samples during imbibition. The anomalous rate of imbibition along the cracks shows on the curves as irregular breaks.

The artificially pressed aggregates of argillaceous rocks are not always quite suitable for imbibometric study. We cannot be sure of the uniform orientation of the flaky crystals when the powder is pressed.

Imbibition of Water by Pulverized and Artificially Pressed Kaolin from Sedlec (20, 30, 40 atm)

Under the conditions described above, the pulverized and sieved sample of natural kaolin almost free of quartz from Sedlec, Bohemia (no. 3) was pressed into cylinders having a base of 100 mm² under pressures of 20, 30 and 40 atm (± 0.5 atm). Each was pressed for 60 sec. Figure 8 shows the
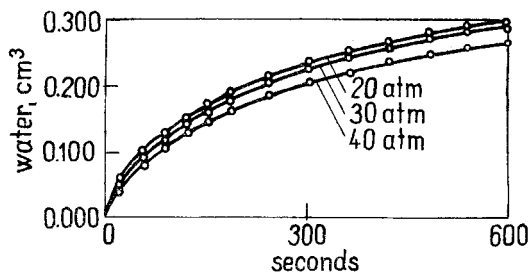

FIGURE 8.—Rate of water imbibition by artificially pressed aggregates of kaolin from Sedlec, Bohemia.

variation of rate of water imbibition with the pressure that the samples have undergone. The higher the pressure the slower is the rate of imbibition, since with higher pressure the porosity decreases. The difference in the rates of imbibition by aggregates pressed at 20 and 30 atm is small. The form of both these curves is very similar to the curve obtained for imbibition of water by the ground flat section of the natural aggregate of the 100 mm² size. From this it can perhaps be inferred that the natural kaolin could not have had a greater weight of overburden than the pressure corresponding to 20 or 30 atm.

Imbibition of Water by Ground Flat Sections of Natural Argillaceous Aggregates Having an Area of 100 mm²

In order to see that the liquid is imbibed by a constant area, prisms having a square base of 100 mm² were cut from the eleven samples with a handsaw and their sides were ground on emery cloth. All the prisms were cut so that

the square base was parallel to the stratification of the rock wherever it was visible. The height of the prisms was between 15 and 20 mm. In samples where the stratification was not visible the prisms were cut in different directions. The prism was carefully cleaned with a soft brush and was put into the glass crucible of 100 mm² base to rest on the glass filter plate. Immediately after this was done, a gradual decrease of the liquid in the pipette was observed. The liquid was imbibed by the prism at the temperature of 20° C and the process of imbibition was observed for 1200 sec. The results are represented graphically in Figs. 9 and 10 in which the vertical axis shows the amount of water imbibed, in cm³, and the horizontal axis shows the time in seconds.
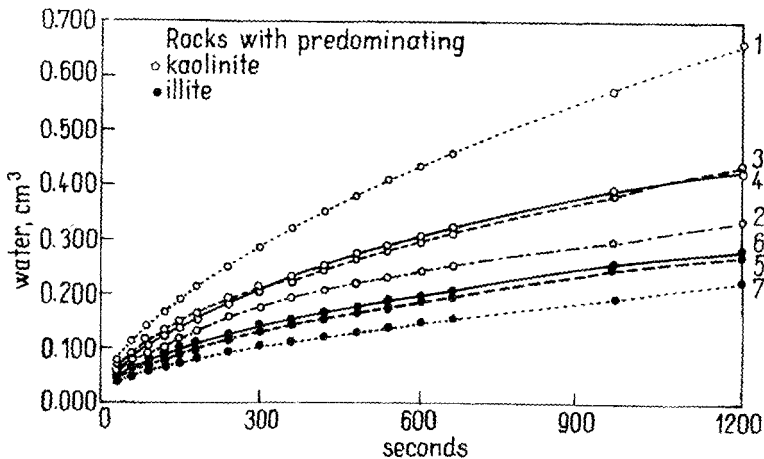

FIGURE 9.—Rate of water imbibition by natural nonswelling argillaceous aggregates on area of 100 mm². Nos. 1, 2, 3, 4, rocks with predominating kaolinite; nos. 5, 6, 7, rocks with predominating illite.

The fastest rate of imbibition was observed in the swelling clays (nos. 8, 9, 10, 11) since there is a multiple increase in the effective porosity during imbibition due to swelling. The rocks with predominating kaolinite imbibe water more slowly (nos. 1, 2, 3, 4) and in the rocks with predominating illite the rate is slowest (nos. 5, 6, 7). The results agree well with the imbibition results obtained by using a drop of water on ground flat sections (Konta, 1961). In nonswelling clays the decisive factor for the rate of imbibition is the total surface area of the particles. With the increase of the total surface area of mineral particles the penetration of the liquid into the clay aggregate through the pores is checked.

The data on speed of water imbibition by an oriented, constant area of 100 mm² of natural argillaceous nonswelling rock can be used for computation of the constant k in the sorption equation. Only samples thus prepared make possible the correct use of the sorption apparatus after Schmidt.
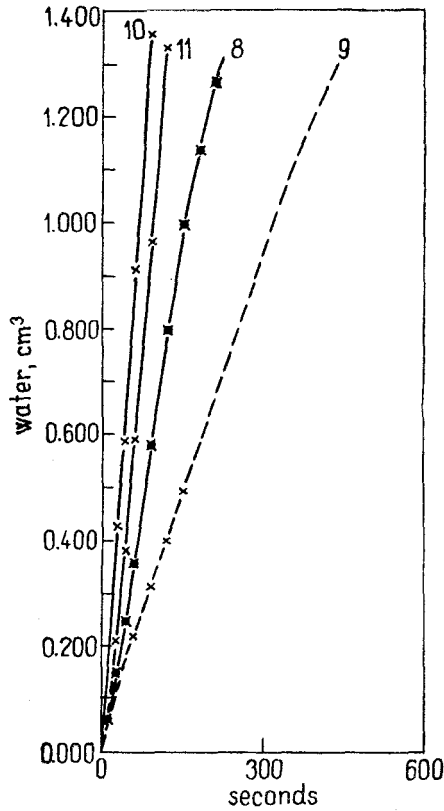
FIGURE 10.—Rate of water imbibition by natural swelling argillaceous aggregates on area of 100 mm². No. 8, clay with predominating "open" illite; 9, 10, 11, rocks with predominating montmorillonite.
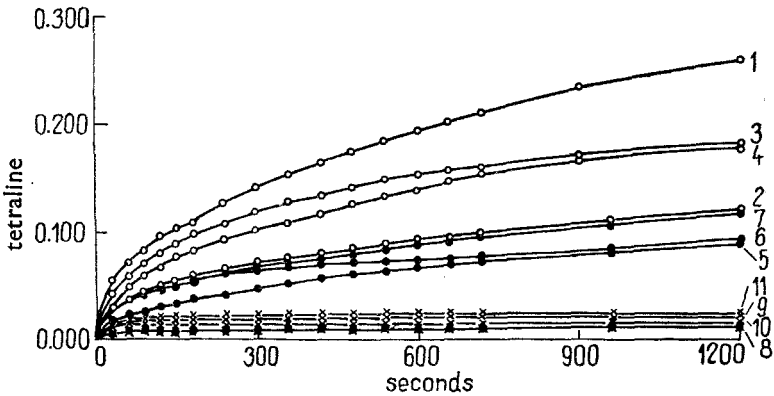

FIGURE 11.—Rate of tetraline imbibition by natural nonswelling (nos. 1 to 7) and swelling (nos. 8 to 11) argillaceous rocks.

Imbibition of Tetraline by Ground Flat Sections of Natural Argillaceous Aggregates of 100 mm² Area

Data on the speed of tetraline imbibition are more suitable for computation of the constant k, since the rate of imbibition when this nonpolar liquid is used is not influenced by swelling. The course of imbibition of tetraline was studied in the same way as the imbibition of water. The temperature of the tetraline used varied from 20 to 21° C. The results of the imbibition course are shown in Fig. 11. During imbibition of tetraline the influence of swelling ceases and the main role is played by the value of the total surface area.

COMPUTATION OF THE CONSTANT THAT INVOLVES THE FORM OF PARTICLES AND TORTUOSITY OF PORES IN ARGILLACEOUS ROCKS

From the experimental data obtained for imbibition of water by the seven nonswelling or apparently nonswelling argillaceous rocks, and from the

Table 1.—Values for Computation of the Constant k

Sample	s = total surface area cm²/cm³	ϵ = effective porosity percent	ϵ^3 = (percent of effective porosity divided by 100)³
1. Kaolinitic clay, Nová Ves, Bohemia	108.50×10^4	43.8	0.084027672
2. Kaolinitic clay, Staré Sedlo, Bohemia	117.85×10^4	31.5	0.031255875
3. Kaolin (almost without quartz), Sedlec, Bohemia	90.85×10^4	37.0	0.050653000
4. Silty kaolinitic clay, Jarov, Bohemia	156.78×10^4	35.5	0.044738875
5. Illite–kaolinitic clay (red), Chlum, Bohemia	218.08×10^4	33.6	0.037933056
6. Illitic clay (ocherous white), Chlum, Bohemia	196.29×10^4	35.1	0.043243551
7. Illitic clay, Füzérradvány, Hungary	413.66×10^4	44.4	0.087528384
8. Illitic clay ("open" illite), Vonšov, Bohemia	1013.71×10^4	13.8	0.002628072
9. "Bentonite", Braňany, Bohemia	958.93×10^4	17.7	0.005545233
10. Montmorillonitic clay, Isten-mezö, Hungary	1898.00×10^4	19.6	0.007529536
11. "Bentonite", Komlóska, Hungary	1869.00×10^4	11.4	0.001481544

Values for water
  η (viscosity) H_2O at 20° C = 0.01 P
  σ (surface tension) at 20° C = 72.75 dyn/cm²
  A (area of imbibition) = 1 cm²

Values for tetraline
  η $C_{10}H_{12}$ at 20.6° C = 0.0228 P
  σ at 20.6° C = 35.4 dyn/cm²

  $A = 1$ cm²

further physical factors controlling the rate of imbibition, the constant k was computed according to the following equation:

$$k = \frac{s \cdot \eta}{\epsilon^3 \cdot \sigma \cdot t} \left(\frac{q}{A}\right)^2 \quad \text{(see Konta, 1961).}$$

Using tetraline the constant k was computed for all eleven samples including the rocks with predominating "open" illite (no. 8) and montmorillonite (nos. 9, 10, 11). Table 1 contains the values necessary for the computation of k.

The form of the mineral particles and tortuosity of the pores in the aggregate are the factors that determine the constant k. For computation of k only that part of the imbibition curve is suitable in which the experimental points lie almost in a straight line. The higher rate of decrease in volume of

TABLE 2.—EXAMPLES OF COMPUTATION OF THE CONSTANT k FROM THE GRADUAL COURSE OF WATER AND TETRALINE IMBIBITION
No. 3. Kaolin (almost without quartz), Sedlec, Bohemia

WATER Amount of water imbibed on 100 mm² area (cm³)	$Q = \frac{S \cdot \eta}{\epsilon^3 \cdot \sigma}\left(\frac{q}{A}\right)^2$	Time of imbibition (sec)	Q/t	k
0.094	21.78*	60	21.78/60	0.36_3
0.208	106.67	300	106.67/300	0.35_6
0.297	217.47	600	217.47/600	0.36_3
0.383	332.05	960	332.05/960	0.34_6
0.431	457.94	1200	457.94/1200	0.38_2

TETRALINE Amount of tetraline imbibed on 100 mm² area (cm³)	Q	Time of imbibition (sec)	Q/t	k
0.058	38.86†	60	38.86/60	0.64_8
0.079	72.10	120	72.10/120	0.60_1
0.119	163.6	300	163.6/300	0.54_5
0.152	266.9	600	266.9/600	0.44_5
0.170	333.9	960	333.9/960	0.34_8
0.180	374.3	1200	374.3/1200	0.31_2

$$* \; Q = \frac{90.85 \times 100}{0.050653 \times 72.75}\left(\frac{0.094}{1}\right)^2 = 21.78$$

$$\dagger \; Q = \frac{90.85 \times 228}{0.050653 \times 35.4}\left(\frac{0.058}{1}\right)^2 = 38.86$$

the liquid in the pipette at the earlier stage of imbibition is caused by the fact that the liquid drawn from the pipette at this stage not only is imbibed by the clay but also forms a thin layer between the prism and the filtration plate; this later acts as a mediating layer. The other reason is that the amount of capillary water in the pores of the aggregate is not uniform throughout the prism and there is less capillary water at the surface than inside. As soon as the pores at the surface are filled with the liquid the effective porosity of the prism remains almost constant. Uniform rate of imbibition is observed after about 500 sec in the kaolinite aggregates, and after
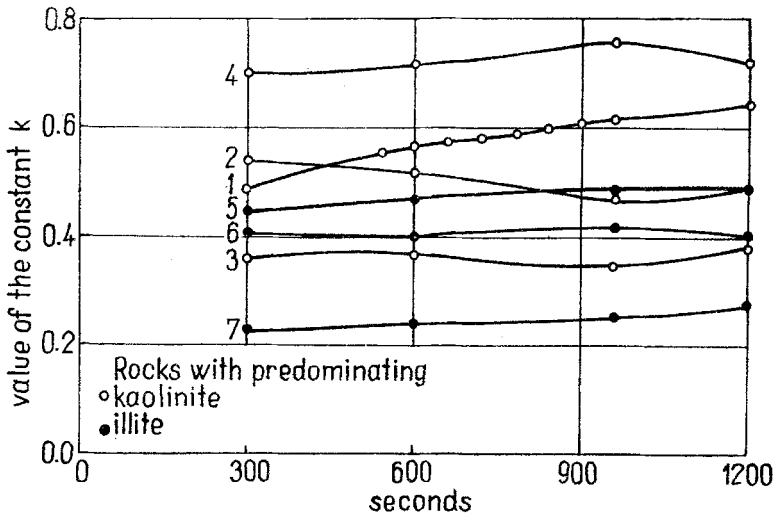

Figure 12.—Variation in the constant k during the course of imbibition of water by argillaceous rocks with predominating kaolinite (nos. 1, 2, 3, 4) and illite (nos. 5, 6, 7).

about 350 sec in the aggregates with predominating three-layer minerals. (The values given are valid for water in megascopically nonswelling clays and for tetraline in swelling clays.) In Table 2 examples of the computation of the constant k for water and tetraline are given.

The variation in k during the course of imbibition of water is shown graphically in Fig. 12. The average value of the constant computed from the imbibition values for water in the range of 600 to 1200 sec of fluent imbibition by argillaceous rocks with predominating kaolinite and illite without a greater admixture of silty or silty-sandy material is about 0.42. The same average value calculated for the imbibition of water after 1200 sec is 0.41. With silty or silty-sandy admixtures, chiefly quartz and muscovite, the value of the constant is markedly higher. Clay no. 4, containing 30 to 35 percent silty admixture, gave the value 0.73 for k when computed for the water

imbibition in the range 600–1200 sec, and the same sample gave the value 0.72 when computed for water imbibition after 1200 sec. The cause of this is the difference in the form of clay mineral particles and the clastic grains, mainly quartz. The computed values of the constant k obtained by fluent imbibition of tetraline on the area of 100 mm^2 for a period of 1200 sec are shown graphically in Fig. 13. The values of k after the stabilized imbibition
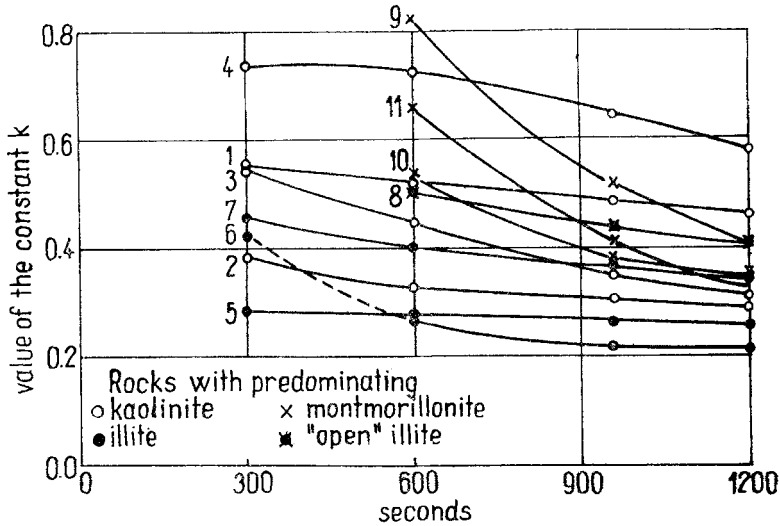

FIGURE 13.—Variation in the constant k during the course of imbibition of tetraline by argillaceous rocks with predominating kaolinite (nos. 1, 2, 3, 4), illite (nos. 5, 6, 7), "open" illite (no. 8) and montmorillonite (nos. 9, 10, 11).

of tetraline beyond 1200 sec have less dispersion and are more accurate than the values for water. During imbibition, water, which has marked polarity, causes even on the clays with predominating kaolinite and illite a little swelling which can hardly be observed macroscopically. This slight swelling causes a faster rate of imbibition. Tetraline as a nonpolar liquid does not cause swelling. The average value $k = 0.32$ in unconsolidated (both nonswelling and swelling) argillaceous rocks, without a higher admixture of silt, was computed from the fluent imbibition of tetraline after 1200 sec when the imbibition course was almost stable.

The described experimental work can be used in solving various problems in the branches of engineering geology, petroleum geology, ceramic technology and others, where problems arise out of the mutual effects of the liquids and porous materials.

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