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A PRELIMINARY ASSESSMENT OF MINERALOGICAL CRITERIA ON THE
UTILITY OF ARGILLACEOUS ROCKS AND MINERALS FOR
HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL

Otto C. Kopp*

*Department of Geological Sciences, University of Tennessee,
Knoxville, Tennessee.

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ABSTRACT

Shales and clay-rich rocks possess very favorable properties for the isolation and containment of high-level radioactive waste. Clays and mixtures of clay minerals with other substances also appear to be among the most suitable materials for buffers and backfill in underground repositories.

The purpose of this study was to review available data concerning the properties reported for these rocks and minerals to determine whether such information could be instrumental in selecting the more favorable assemblages of clays for waste repository purposes.

Literature searches were conducted for reports dealing with the properties of these argillaceous materials. The properties that were obtained from appropriate references were recorded in an Appleworks Database (Appendix A). The data are divided into five major groups: chemical properties, general physical properties, hydrologic properties, mechanical properties, and thermal properties. The Database includes such information as the type of material, formation name, geological age, location, depth, test conditions, results, and reference(s). Partial data are recorded in separate Appendixes based on property (Appendix B), material (Appendix C), and formation name (Appendix D).

In general, noticeable correlations were not apparent when mineralogical information was compared with various properties using plots of the data for each individual property. The best correlations were obtained for chemical and certain mechanical and hydrologic properties. Thermal properties appear to be least influenced by clay mineral composition.

An important reason for the inability to correlate mineralogical compositions with most properties was the lack of uniformity of test methods, test conditions, and even the units used for reporting the final data. Also, there was very limited information concerning the mineralogical compositions of most of the shales tested.

The potential exists for identifying the more suitable formations (or specific horizons within formations) using mineralogical data; however, in order to make such selections, it will be necessary to collect future data using standardized

test methods and conditions. The mineralogical compositions of the samples tested need to be determined quantitatively rather than qualitatively. In addition, information relative to the character of argillaceous rocks (e.g., degree of preferred orientation of the clay flakes, and the nature and extent of cementation) will aid our understanding of the relationships between mineralogical composition and rock properties.

1. INTRODUCTION

The Oak Ridge National Laboratory (ORNL) recently completed a comparative evaluation of five sedimentary rocks (CROFF 1986a, 1986b, and 1986c), notably shales, carbonates, sandstones, anhydrite, and chalk, to determine their relative potential as host media for the disposal of high-level radioactive wastes. On the basis of generic features and characteristics, shale was determined to have the greatest potential for waste repository development.

Thick and extensive deposits of shale underlie most regions of the United States (GONZALES 1985). These possess a wide range of chemical, hydrologic, mechanical, and thermal properties. Furthermore, shales consist, for the most part, of clay minerals or clay-sized mineral grains. The most common groups of these clays are illite, smectite, chlorite, and kaolinite. With variations in the types and quantities of clays as well as nonclay constituents, such as quartz, it is not unexpected that shales show wide differences in properties and behavior. With increasing age, temperature, and pressure, illitic clays tend to dominate in shale deposits while smectitic clays are frequently most abundant in younger sediments. Carbonate and carbon contents are usually low in shales but, in certain deposits, may range up to 50% for the former and 15% for the latter. Thus, the type and amount of clay, organic content, and carbonate content are the greatest variables in shale compositions.

In order to select shales that possess the most favorable characteristics for repository utility, it is apparent that data on the chemical, hydrologic, mechanical, and thermal properties of various shale types are

needed, along with the mineralogical compositions of these shales. The initial step in this investigation was to survey the literature for measured values of material properties and to attempt to correlate them with the main group of mineralogical assemblages.

Several difficulties were apparent while trying to utilize the available literature data for comparing the compositions of shales and other clay-rich material with various properties. There was a lack of uniformity in the test methods and conditions, as well as the units used for reporting the results. These problems will be addressed in detail later.

2. CLAY MINERAL PROPERTIES

The intention of this report is to review the relationships between mineralogical composition and the properties of shaly rocks. For details concerning the mineralogic aspects of clay minerals, the interested reader is referred to standard clay mineralogy texts (e.g., GRIM 1968; MILLOT 1970; NEMECZ 1981) or to recent reports (e.g., WEAVER 1979; MEYER 1983) concerning the disposal of radioactive wastes.

Clay mineral properties can be difficult to measure accurately for several reasons. First, pure clay minerals are rather rare. Other constituents, such as quartz, feldspars, aluminum and/or iron oxides and hydroxides, organic matter, and other minor minerals, are usually present. Unless steps are taken to remove all impurities first, the test results will apply to a mixture of minerals rather than to a pure clay. On the other hand, if attempts are made to purify the clay, it is generally necessary to separate the impurities through mechanical and chemical treatments, and the resulting "pure" clay may differ from the material present in the rocks at a waste repository. Second, many important properties must be measured over long time intervals and/or distances. Attempts to measure such properties in the laboratory in small samples and in relatively short time periods may give results that are unrealistic when actual repository conditions are considered. Third, the interaction of clays with pore fluids of various compositions may result in changes in physical and/or chemical properties. Fourth, universally accepted laboratory methods are not available for many

important properties; hence, even when splits* of the same material are tested, different workers may get different results. Fifth, the fact that different terms are sometimes used for essentially the same measured property and the lack of uniformity in the units used to express the results (especially in the older literature) make it difficult to compare and evaluate data obtained from different sources or measured at different times.

The nature of clay mineral properties will be outlined first because we need to know what these properties are, how they are determined, and how valid the determinations may be. Only then can we review the present state of knowledge about clays to see if the desired pieces of information are available, missing, or not well known.

Clay mineral properties may be divided into five major groups: chemical, general physical, hydrologic, mechanical, and thermal. The reader should bear in mind that many individual properties are closely interrelated. For example, two specimens of the same clay mineral compacted at two different pressures and/or moisture contents (hence having different densities) will differ in hydraulic conductivity. Likewise, hydraulic conductivity is strongly influenced by chemical bonds with water molecules at clay mineral surfaces and the nature of other chemical species present in the pore fluids.

The Database presented in Appendix A was prepared using the following references: BEALL 1982; BOCOLA 1981; BRADLEY 1983; CHAPMAN 1985; CROFF 1986a, 1986b, and 1986c; COUTURE 1983; DOE 1980, 1981; GONZALES 1985; GRAY 1984; KIBBE 1978; LOMENICK 1983; MEYER 1983; MOAK 1981; NEA 1979a, 1979b, 1981; OSCARSON 1983; PUSCH 1977, 1978; ROY 1982; SOUDEK 1983; WEAVER 1973, 1976, 1979; and WOOD 1981. Several other reports and report abstracts were examined but omitted because they contained no apparent useful information for this review.

Chemical properties (Appendix A.1) include batch distribution ratio, diffusivity, ion-exchange capacity, and sorption coefficient.

*A split is defined here as a representative portion of a sample having the same mineralogy, chemical composition, and textural characteristics as similar portions of the same sample used for measuring other properties.

General physical properties (Appendix A.2) include density, moisture content (or water content), porosity, specific gravity, specific surface, and void ratio.

Hydrologic properties (Appendix A.3) include groundwater travel distance, hydraulic conductivity (and permeability), inflow, specific storage, and travel time.

Mechanical properties (Appendix A.4) include bulk modulus, cohesion, compressive strength, friction angle, plasticity (liquid limit, plastic limit, plastic or plasticity index, and shrinkage limit), Poisson's ratio, shear modulus, shear strength, swelling, swelling distance, swelling pressure, tensile strength, and Young's (elastic) modulus.

Thermal properties (Appendix A.5) include coefficient of linear expansion, heat capacity and specific heat capacity, thermal conductivity (heat conductivity), and thermal diffusivity.

A discussion of these individual properties follows.

3. CHEMICAL PROPERTIES

Chemical properties include batch distribution ratio (R_d) and sorption coefficient (K_d), ion-exchange capacity, and diffusivity. The first two properties are closely related and are measured by determining both the quantity of specific ions sorbed by the clays and clay-rich rocks being studied and the quantities of those ions remaining in the fluid phase. The appropriate equation is:

$$K_d = \frac{\text{g radionuclide on sorbent/g sorbent}}{\text{g radionuclide in fluid/mL fluid}} .$$

[Note: K_d describes the distribution of a trace element between two substances measured at equilibrium. In those cases where equilibrium is not proven, the term R_d may be used instead of K_d . Many of the values stated in the literature as K_d 's are probably actually R_d 's.]

These measurements are very sensitive to experimental conditions (temperature, pH, Eh, concentration, valence states, nature and concentrations of other ions present, etc.) and often show quite a range of

values even for a single mineral species or rock type. Ion-exchange capacity (either cation or anion) is a related property but, in a strict sense, refers only to those ions that can be adsorbed onto exchange sites. There is no obvious mathematical relationship between batch distribution ratio or sorption coefficient and ion-exchange capacity; however, minerals that possess large ion-exchange capacities are likely to have large sorption coefficients.

Mass transport depends on hydraulic conductivity and the effective mass diffusion coefficient (OSCARSON 1983). If hydraulic conductivity is low, diffusion may be the dominant mechanism. Diffusion is strongly influenced by the Kd and is difficult to measure; hence, there are few values for properties such as diffusivity available.

Chemical properties will be very important in the selection of sites for waste disposal. The waste containers, buffers, and other nearby materials that may be used to isolate radioactive wastes may be breached by mechanical means or through corrosion. In that event, the surrounding host rock will act as the ultimate container, retarding the flow of fluids (into and/or out of the containers) and sorbing the radionuclides from any fluids that might escape. Many clay minerals do not have good sorption properties for anions such as iodine. Some workers (e.g., BEALL 1982) have suggested that other minerals (e.g., cinnabar, galena, and chalcocite) may be added to the buffer to sorb such anionic species.

The role of organics is also thought to be important. Organic compounds may react directly with some radionuclides. In addition, the presence of organic matter may influence the pH and Eh of the local environment and lead to changes in the valence states of certain radionuclides, which in turn could significantly change their solubilities and sorption behavior.

4. GENERAL PHYSICAL PROPERTIES

Density (the mass per unit volume of a substance) is an important property of clays and clay-rich rocks. The density value reflects not only the proportions of mineral matter and void spaces, but it can also be used to estimate the depth of burial of shale or as an indicator of the stress applied to clay-rich material (e.g., artificially compacted material).

Note that density can be determined for material that has been air-dried or oven-dried, is moist (as taken from saturated material), has been equilibrated with moist air, etc., or the density of the grains that comprise the sample can be measured. If the specific type of density determined was stated, it is listed in Appendix A.2. However, since the type of density may not be stated, caution is advised when comparing the results from several different sources. In some cases, tests were performed on clay minerals to which specific amounts of water had been added. (This is usually stated.) Caution is also advised if there is any evidence that the material was oven-dried since the properties of clay minerals, such as the smectites and halloysite, may be irrevocably changed if dried above certain temperatures in air. The results for samples of shales and other clay-rich rocks that were exposed to the atmosphere for extended periods prior to the determination of density will not represent the *in situ* values for the rocks. (The same statement applies to any properties measured on samples that have been allowed to dry out.) Values listed for specific gravity are normally dimensionless but can be readily converted to density values.

Several other important parameters, such as its hydraulic and thermal properties, are influenced directly or indirectly by the density of a rock sample. In fact, many important physical and chemical parameters are interrelated. Unfortunately, when various materials are tested, it is not feasible to change all of the possible variables; hence, specific tests relating two variables may be determined at only one or two temperatures, at a given pH, or under some other set of fixed conditions. In many cases, the experimental conditions are not stated in the reports examined. (However, some of this information may be available in the original references.)

Porosity and void ratio measure the amount of pore (open) space left between the solid mineral grains. Porosity expresses the percentage of pore space as compared with the total volume of the sample (total volume of pores divided by total volume of sample, multiplied by 100%). The meaning of effective porosity is less well defined but is taken here to be similar to that of porosity except that the pore space measured is limited to interconnected pore space from which fluids can migrate or into which fluids can enter. Like porosity, effective porosity is expressed as a

percentage. For a given sample, effective porosity cannot exceed porosity; and, in general, the effective porosity is a much smaller percentage. In some reports, no dimensions are stated. Void ratio is a dimensionless number that expresses the ratio of the total volume of the pore spaces to the total volume of the solid (note that the ratio is not compared with the total volume of the sample).

Accurate determination of porosity is not easily accomplished. One technique uses mercury under pressure, which is forced into ever-smaller pore spaces. Porosity changes with depth and degree of cementation and, therefore, is markedly affected by grain size and shape distributions. Like bulk density, porosity is interrelated with many physical and chemical properties. For example, the amount of porosity and the nature of the substances that fill the pores of a rock will influence both its hydrologic and thermal properties.

Moisture content (or water content) designates the amount of water (usually in weight percent) contained in a clay or clay-rich rock. In some cases, the value represents the amount of water added to a clay or rock by the investigator in order to change its properties.

5. HYDROLOGIC PROPERTIES

The two most frequent measurements are hydraulic conductivity (K) and permeability (or intrinsic permeability) (k). Permeability, which is a measure of the ability of a substance to transmit fluids, is determined by several factors, including the rate of flow of the fluid (q), the cross-sectional area of the porous medium (A), the pressure drop along the length of the sample (Δp), the length of the sample (L), and the viscosity of the fluid (μ). The relationship among these variables is:

$$q = \frac{kA\Delta p}{\mu L} ,$$

where μ is in centipoises.

More recently, most investigators use K to characterize the flow of fluids through porous media. Hydraulic conductivity is determined by the density of the fluid (ρ_w), the acceleration due to gravity (g), the

permeability of the solid (k), and the viscosity of the fluid (μ). The relationship among these variables is:

$$K = (k\rho_w g)/\mu ,$$

where k is given in square centimeters.

The terms permeability and hydraulic conductivity are often used interchangeably; hence, it is important to look at the units of measurement to determine which property was measured. They are related by:

$$K = 9.6 \times 10^{-7} k$$

and

$$k = 1.033 \times 10^6 K.$$

Physical factors that influence hydraulic properties include grain packing, compaction history, grain size, grain size distribution, and the grain shapes. Morgenstern has presented evidence to show that in fine-grained rocks the particle arrangement dominates the hydraulic flow properties (RIEKE 1974).

Less information is available for specific storage, which refers to the volume of water taken into storage, or discharged, per unit volume of rock for a unit change in hydrostatic head. The equation for specific storage is:

$$S_s = \rho_w g (1/E_s + \phi/E_w) ,$$

where

S_s = specific storage,

g = weight of a unit volume of interstitial fluid,

E_s = modulus of compression of matrix,

ϕ = porosity, and

E_w = bulk modulus of the interstitial fluid.

Specific storage is related to the elastic properties of sediments and water. Few of the reports checked thus far have made reference to this property, but it may be a useful measurement in future studies of waste disposal sites.

Only limited references were made to properties such as groundwater travel distance, inflow, travel time, and hydraulic diffusivity. Groundwater travel distance is the distance (in meters) that groundwater will travel in 100,000 years. Inflow is an estimate (calculated) of the rate at which groundwater will flow into mined openings, making certain assumptions about the size of the opening, the hydraulic head, and extent of the saturated zone. Travel time is the length of time (years) that it will take (calculated) for groundwater to travel between the disturbed zone and the accessible environment.

6. MECHANICAL PROPERTIES

Strength, elasticity, and plasticity are very important mechanical properties of clays and clay-rich rocks. These properties can help us, to resolve important questions concerning waste disposal such as: (1) will an underground opening remain open for a given period of time while materials are being emplaced; (2) will a substrate be capable of supporting vehicles being used to transport material; (3) will a substrate be capable of supporting canisters in a predetermined position; and (4) will manufactured materials (preformed blocks) maintain their shape during handling? There have been a number of recent studies and summaries of past studies concerning these properties. The reader's attention is especially directed to RIEKE (1974), a work which provides detailed explanations of many of the properties of argillaceous materials. Much of this information was developed by researchers during investigations of the sedimentary rocks found in oil fields. Here, vast quantities of argillaceous rocks were subjected to wide ranges of temperature, pressure, and time.

Strength, elasticity, plasticity, and other mechanical properties are affected by many of the other characteristics of clay-rich materials, including the clay mineral composition, the percentage of clays present, the presence of cements and other minerals, the grain size and shape

distribution, the density and/or porosity, the amount of fluids present and the chemical species present in those fluids, the previous compactional history of the material, and the temperature. In many laboratory tests, only two or three variables are measured under a range of conditions. This makes it difficult to compare the results presented by different researchers. These properties will be, in part, site-specific (dominated by the properties of the host rocks) and, in part, determined by the materials and processes used to prepare materials for the buffer and backfill. Published reports of data on various strength properties can only give us ideas concerning the ranges that might be anticipated for clay-rich material.

Young's (elastic) modulus, modulus of rigidity, bulk modulus, and Poisson's ratio have been discussed in detail (RIEKE 1974). These researchers note several reasons why laboratory results (static and destructive) are subject to inaccuracies and why dynamic (nondestructive and/or in situ) measurements are more likely to reflect the true properties of a rock. Equations relating the elastic constants in an isotropic sedimentary rock body are summarized below:

Modulus of elasticity

$$(\text{Young's modulus}): \quad E = 2G(1 + \gamma) ,$$

Modulus of rigidity

$$(\text{Shear modulus}): \quad G = \frac{E}{2(1 - \gamma)} ,$$

Bulk modulus:

$$k = \frac{E}{3(1 - 2\gamma)} ,$$

Poisson's ratio:

$$\gamma = \text{ratio of lateral to longitudinal strain} ,$$

where E is the slope of the stress-strain curve.

Compressive strength, shear strength, and tensile strength may be measured under several different sets of experimental conditions that are not always clearly stated in reports. The presence, or absence, of friction

reduces on the platens can have a significant effect on the test results. In general, the "strength" of a material is determined by measuring the stress that is needed to cause failure. Failure may be manifested by cracking, rupture, shearing, and loss of load-bearing capacity. Data concerning unconfined compression tests of clay-rich material are fairly common; however, such information has limited application to conditions in waste repositories where the material will be mechanically compacted either during emplacement or by stress applied by the overburden within a geologically short time after a repository has been sealed. The strength of clay-rich material is affected primarily by its moisture content and plasticity. In addition, the clay mineralogy, the nature of the exchange sites and the manner in which water is oriented on the clay surfaces, stress history, grain size and shape distribution, confining pressure, temperature, rate of loading, and deformation are all factors that influence strength.

Plasticity can be measured in several different ways. A common method involves measuring the behavior of clays as water is added to the system. The various limits are collectively known as the Atterburg Limits, which are usually determined for soils or unconsolidated material. The plastic limit is given by the minimum weight percent water at which the material exhibits plastic behavior. The plastic behavior begins when enough water has been added to overcome the attractive forces between the individual clay grains and the shear strength of the clay diminishes significantly. The liquid limit is the minimum weight percent water at which the material behaves like a liquid. The plastic, or plasticity, index (liquid limit minus plastic limit) defines the limits of plastic behavior. The shrinkage limit is the weight percent water at which the volume decrease is no longer linearly proportional to the water content.

Plasticity will probably have little influence on the choice of deep disposal sites because of the preexisting compacted nature of the burial formation. These properties could be significant, however, in the selection of shallower sites (or less-compacted formations such as the Gulf Coast clays), and they could also be very important in the selection of buffer and/or backfill materials. For example, through proper selection, the behavior of the buffer and/or backfill could be modified to facilitate emplacement by making relatively small changes in water content.

Conversely, improperly selected material might give a false sense of security. Its strength might be diminished significantly if a small amount of water were added to the system by any means.

Volume stability (swelling and shrinking) is an important aspect of buffers and backfill material, as well as material which may be used to form a seal when a repository is closed. On the one hand, excessive swelling can generate pressure which might damage canisters or surrounding materials. On the other hand, excessive shrinkage might destroy the effectiveness of a seal and admit fluids from external sources or release fluids from within the repository site. Volume stability is affected by clay mineralogy, mineral content, volume of fluids present and their chemistry, porosity (void ratio), grain size and shape distribution, stress history, and temperature. Swelling is a measure of the amount (in percent) of volume change that occurs if water is added to an unsaturated clay under negligible confining pressure. Swelling pressure results if the clay-water mixture is confined. The more plastic clays, such as the smectites, tend to develop higher swelling pressures. Conversely, such clays are apt to undergo the greatest shrinkage when water is removed. Swelling distance refers to the distance that a clay will intrude into a small fracture in the surrounding rock.

7. THERMAL PROPERTIES

Thermal properties that have been measured for clays and clay-rich rocks include the coefficient of linear expansion, heat capacity and/or specific heat (two properties which are closely related), thermal conductivity (k or λ), and thermal diffusivity (D or a). These properties are related to each other by the equation:

$$D = k/C\rho ,$$

where

C = specific heat, and

ρ = density.

Thermal properties are very important because the heat generated by the radioactive wastes must be dissipated through the canisters, buffer, backfill, and the surrounding rock rapidly so that the localized effects are minimized. At the very least, there might be structural changes in nearby clay minerals (which might release water into the system).

Thermal properties can be measured in situ or in the laboratory, or calculated, taking into account the specific heat of the material being tested as well as other physical conditions of a hypothetical repository. Although a modest amount of thermal data is available, there appear to be only a few results derived from the testing of large samples.

8. DISCUSSION

A primary purpose of this investigation was to determine whether data from the literature could be used to select suitable shales or assemblages of clays for high-level waste repositories. Initially, it was thought that sufficient information would be available for a wide variety of materials so that the effects of mineralogical composition on most properties could be evaluated with confidence. In some cases, it may be possible to infer these relationships with a degree of confidence; however, in other cases, it would be foolhardy to try to judge relationships to mineralogy on the basis of the incomplete information presently available. Much of the information in the Database (Appendix A) was obtained from reports that summarized the data rather than being taken from the original references. Thus, it may be desirable to review selected original references to determine whether some of the needed information may be found there.

Several factors contribute to the problems encountered while attempting to establish any relationships. First, although the mineral content is known for many materials tested in laboratory studies of relatively pure minerals (and their mixtures with other minerals and rocks), the mineralogy of rock samples is frequently not given or is only stated in general terms (e.g., "illite-smectite dominant, plus lesser illite, kaolinite and chlorite"), which can only be used qualitatively. Second, the conditions used in the studies are not always stated, and even when this information is included, it is rare to find many samples that were

tested under identical conditions. For example, it is difficult to make a valid comparison of the properties of two samples when one was tested at 25 MPa while "wet" and the other was tested at 200 MPa while "dry." The lack of consistency in units required the use of conversion factors, which introduces the possibility of mathematical error; and, in several cases, the units used for the property were not valid (e.g., thermal conductivity given in W/kg·K). Finally, for some properties (e.g., swelling distance), so few data sets were available that no meaningful comparisons could be made. This task would have been immeasurably easier if everyone who tests materials had a set of guidelines stipulating the information needed concerning the material, test methods, etc., and the units to be used in reporting the results.

8.1 CHEMICAL PROPERTIES

Plots were prepared for two groups of data: batch distribution ratio (Fig. 1) and cation-exchange capacity (Fig. 2). No sorption coefficient plot was prepared at this time because the data are so voluminous and the reported values cover a wide range. No attempt was made to interpret the single data set found for diffusivity.

The available data strongly suggest that the batch distribution ratio and the exchange capacities of clays, shales, etc., can be "predicted" to a high degree if their mineralogical compositions are known. In general, those samples that contain smectite minerals (or bentonite) and smectite-rich mixed-layer clays typically have the best capability for exchanging (or sorbing) cations. Although limited data were available for vermiculite, the same conclusion will probably hold true for this mineral as well as any rocks/soils that contain it as an important constituent.

While kaolinite and illite are generally considered to have less desirable chemical properties, they may have selective properties for certain ion species (e.g., illite for cesium). In general, the sorption coefficients for most clays for anionic species (such as iodine) are low, and it may be necessary to add other materials to correct this deficiency if clays are used in buffers or backfill.

Several other factors should be taken into consideration since they may also influence the behavior of any given material that might be

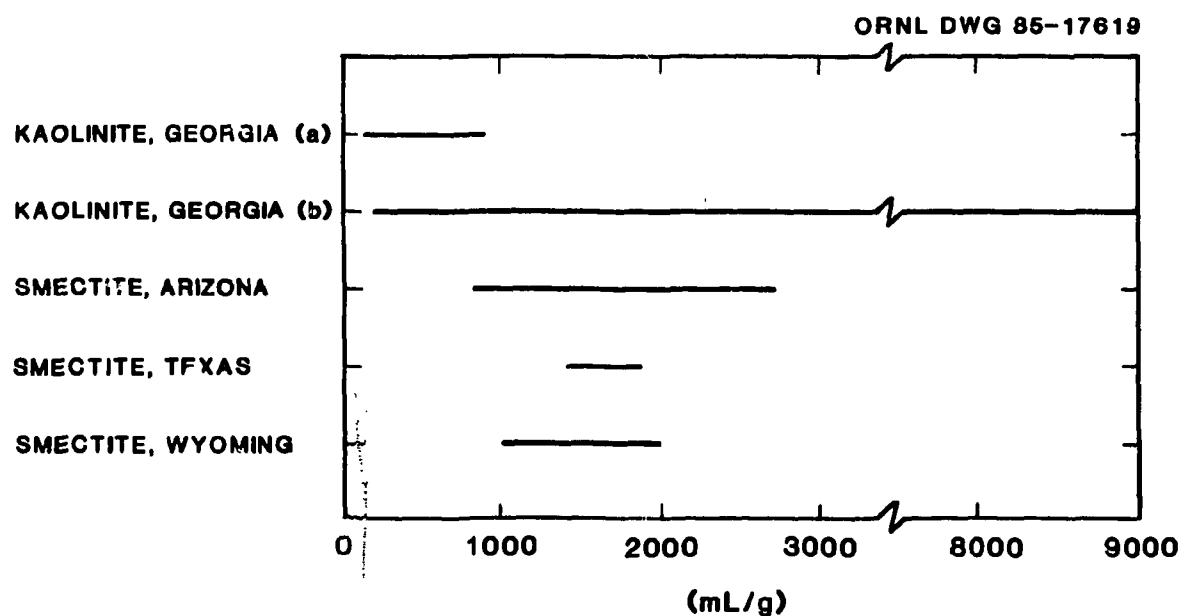


Fig. 1. Batch distribution ratio.

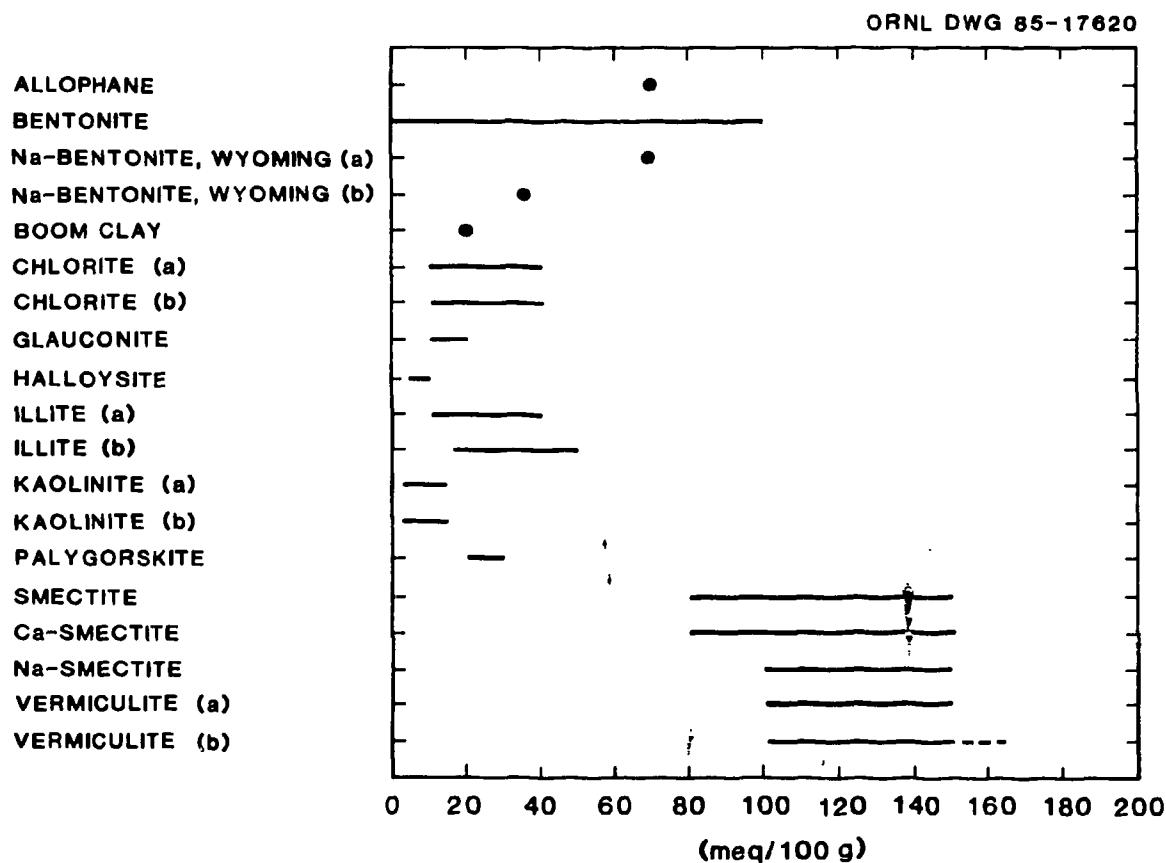


Fig. 2. Cation-exchange capacity.

evaluated. Both the density and the effective porosity of the material will affect its sorptive capacity, as will factors such as the ambient temperature and the physical and chemical conditions of the pore fluids (e.g., pH, Eh, and ion species present).

8.2 GENERAL PHYSICAL PROPERTIES

Plots were prepared for several groups of data, including density (type unspecified) (Fig. 3), density (bulk, natural, grain, etc.) (Fig. 4), density (dry) (Fig. 5), specific gravity (Fig. 6), moisture or water content (Fig. 7), porosity (several types) (Fig. 8), effective porosity (Fig. 9), specific surface (Fig. 10), and void ratio (Fig. 11). Limited data for wet density were not plotted.

The terminology for the several types of density and porosity shows considerable ambiguity. An attempt was made to reduce the number of types, but the nature of the property was also listed on the plots in case it is significant.

Most physical properties are not useful, *per se*, in predicting the suitability of specific rock bodies as host formations; however, for a given rock type (or mixture of minerals), the physical properties will change as other physical conditions change. For example, density generally increases with depth and/or pressure applied by some compacting device; porosity is usually affected in the opposite manner. Density and porosity are also influenced by the mineralogical composition and factors such as the grain size distribution, grain orientations, presence of pore fluids, and presence of cements.

What is potentially most useful is the fact that, for a given material, other properties will vary with respect to properties such as density. One might observe, for example, that for a given mixture of smectite and grains of sand (or crushed granite), the hydraulic conductivity will decrease (rate of flow will diminish) as the material is compacted and the density increases (and, conversely, the porosity decreases).

We may expect to find at least two relationships in natural systems (and be able to control them to some degree in artificial systems):

1. With increasing depth of burial, density will increase and any other properties (whether chemical, hydrologic, mechanical, or thermal) that

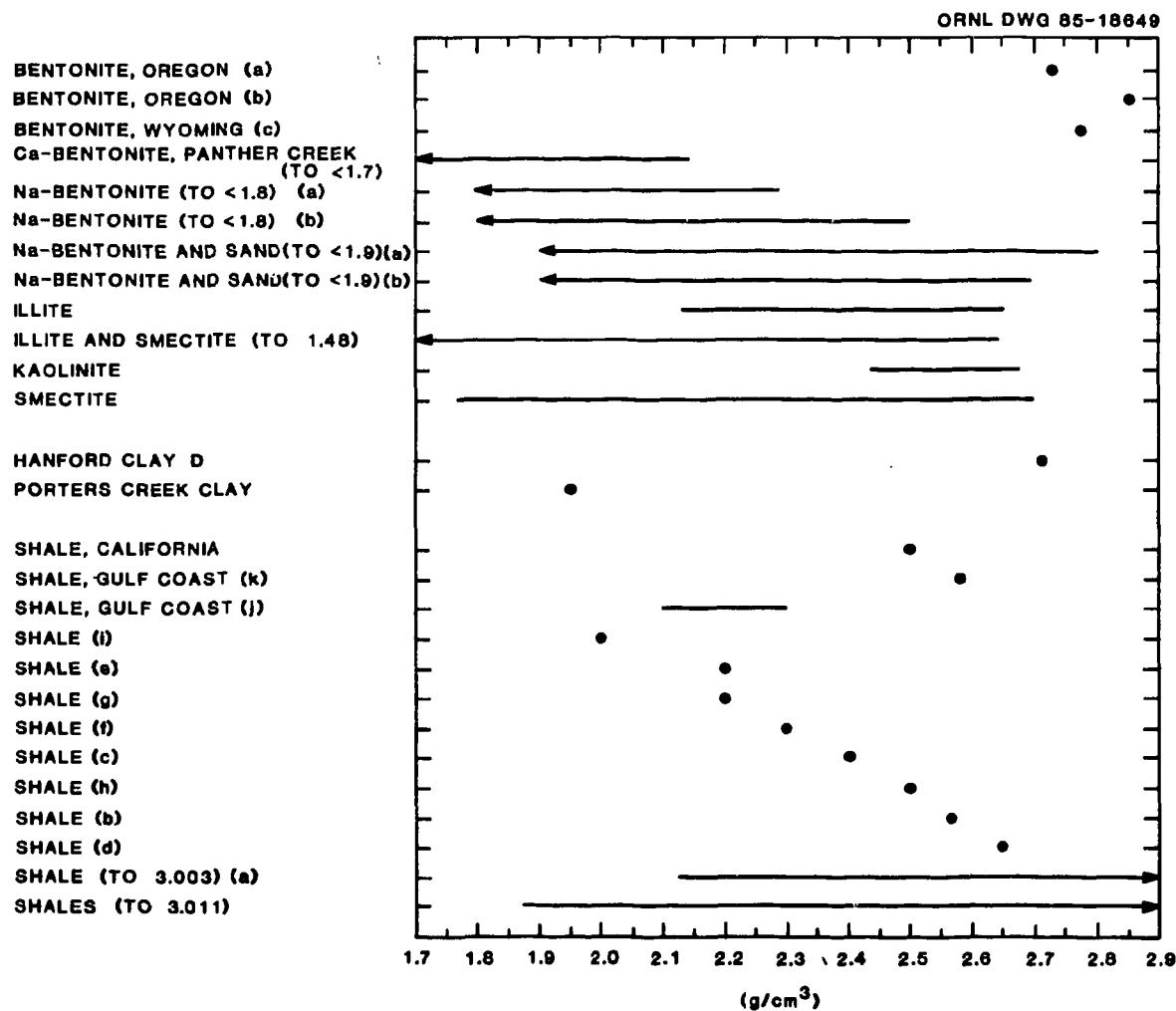


Fig. 3. Density (type not specified).

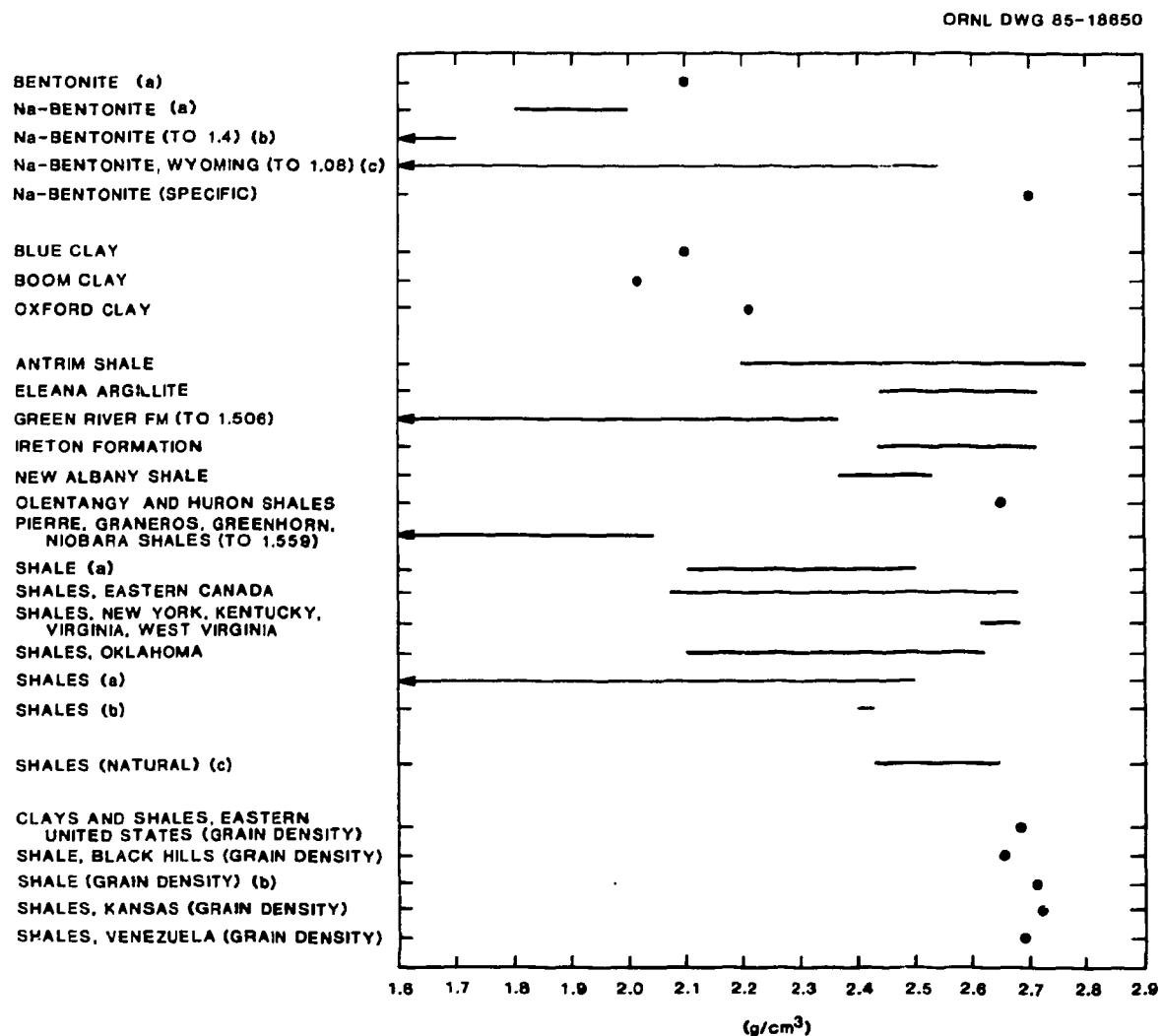


Fig. 4. Density (bulk, natural, grain, etc.).

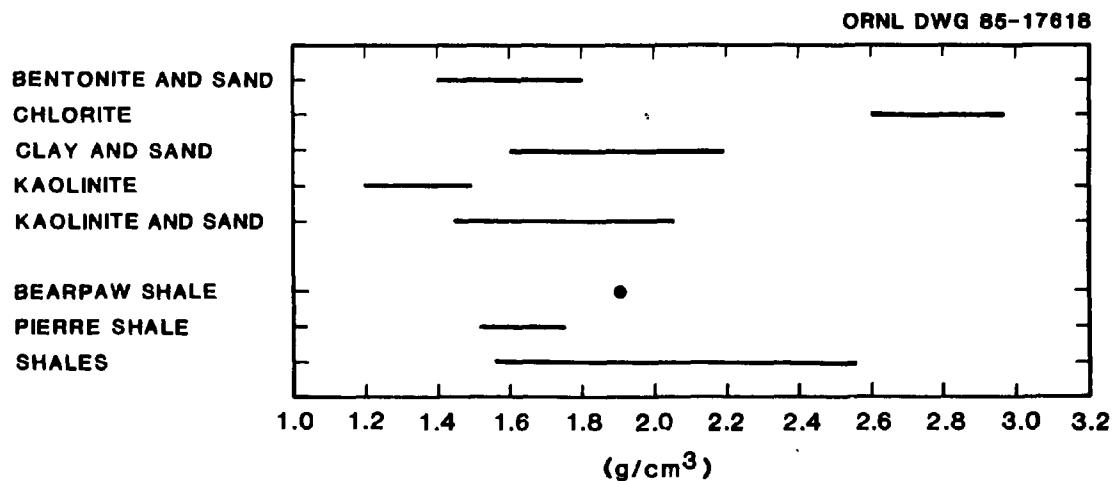


Fig. 5. Density (dry).

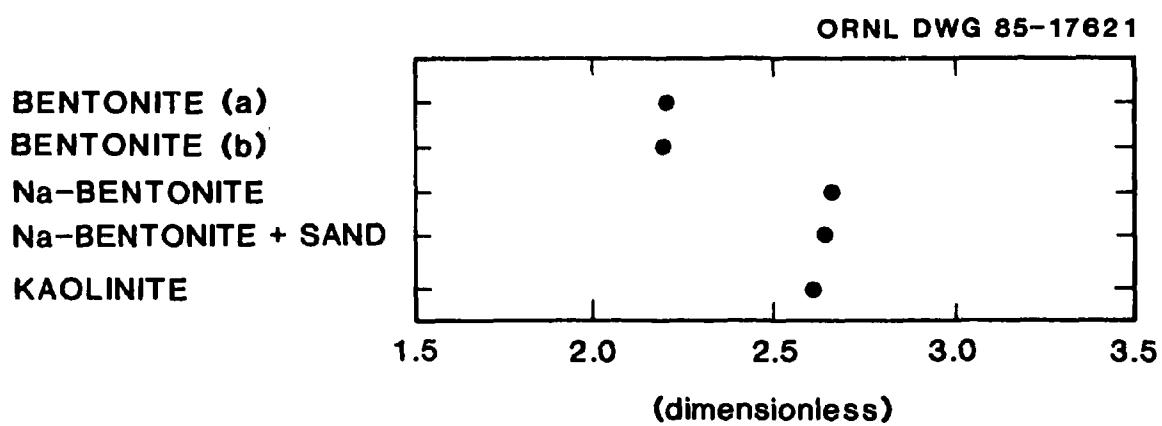


Fig. 6. Specific gravity.

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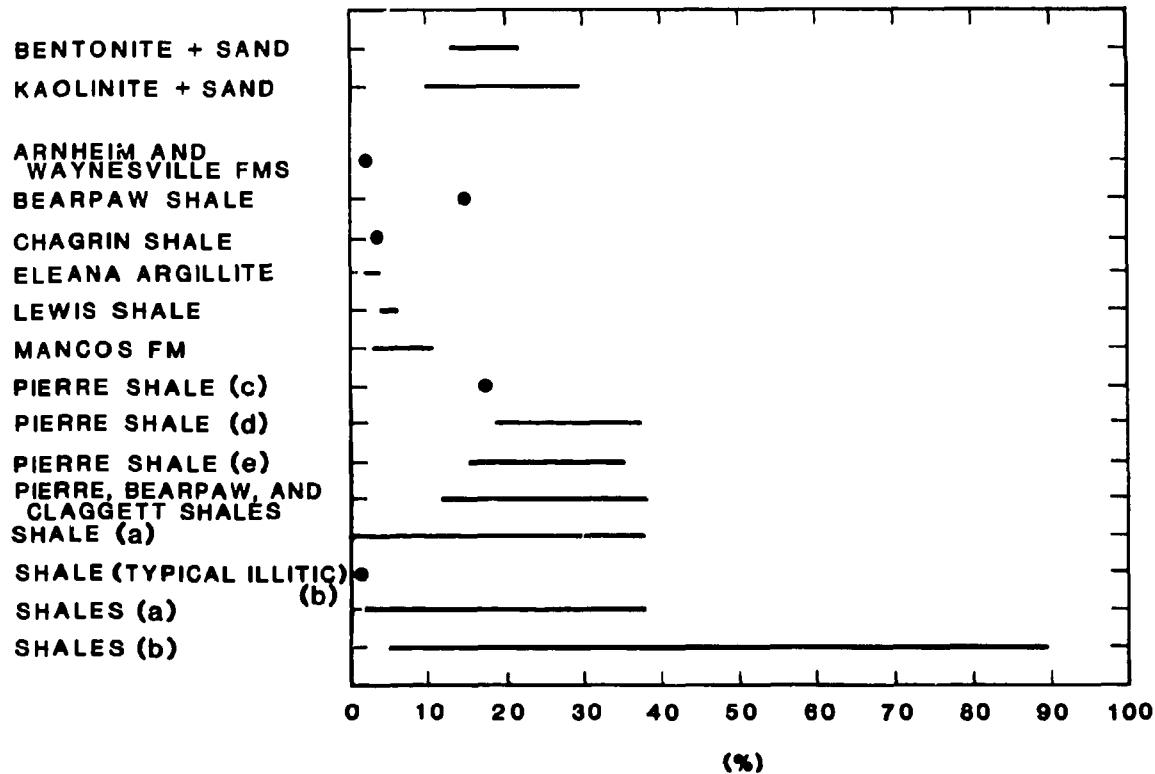


Fig. 7. Moisture (water) content.

BLUE CLAY
BOOM CLAY
OXFORD CLAY

ANTRIM SHALE (a)
ANTRIM SHALE (b)
CHAGRIN SHALE
CONASAUGA SHALE
ELEANA ARGILLITE
MUDDY SHALE
NEW ALBANY SHALE (a)
NEW ALBANY SHALE (b)
OLENTANGY AND HURON
FORMATIONS
PIERRE SHALE
SHALES, APPALACHIAN
SHALES, KENTUCKY (a)
SHALES, KENTUCKY (b)
SHALES, MICHIGAN BASIN
SHALES, NEW YORK, VIRGINIA,
WEST VIRGINIA
SHALES, OKLAHOMA
SHALES, UNITED STATES, EUROPE
SHALE (b)
SHALE (a)
SHALE
SHALES (d)
SHALES (b)
SHALES (e)
SHALES (a)
SHALES (c)
TYPICAL ILLITIC SHALE

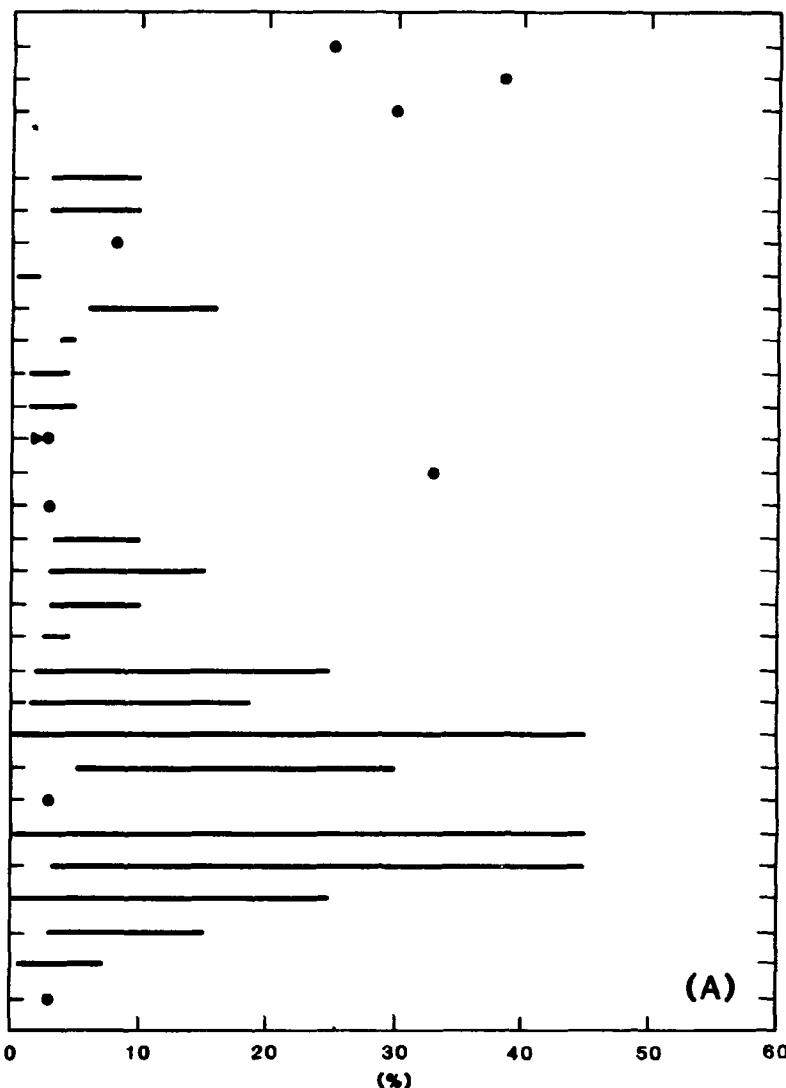


Fig. 8. Porosity (average, primary, rock mass, total, etc.) in
(A) % and (B) units not stated.

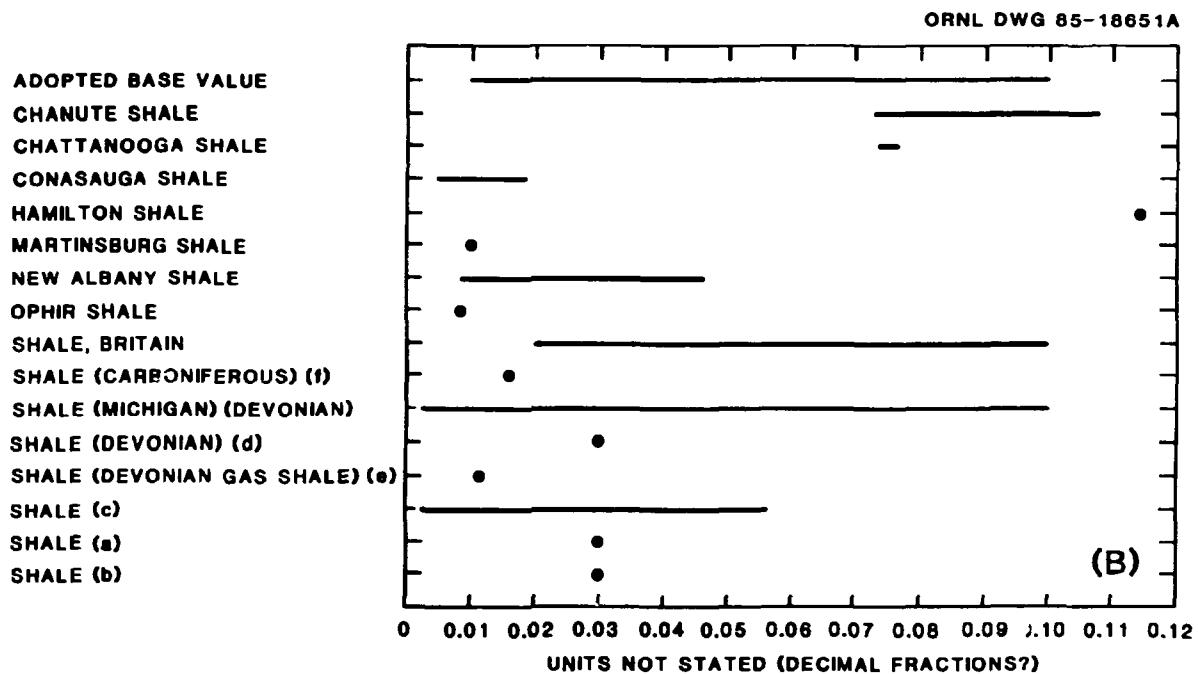
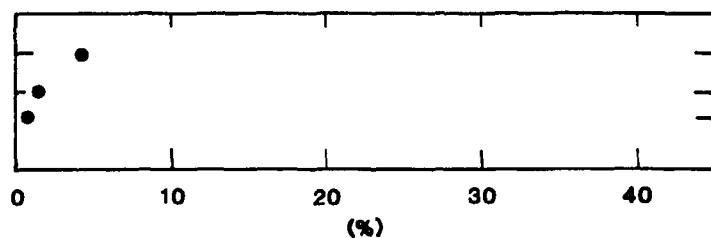


Fig. 8 (Continued).

ORNL-DWG 85-17622

ARNHEIM AND WAYNESVILLE
FMS
SHALES, PENNSYLVANIA
SHALES, SOUTH CAROLINA



ADOPTED BASE VALUE
BENTONITE AND SAND
ILLITE
KAOLINITE

SHALE (a)
SHALE (TRIASSIC)
SHALES, SOUTH CAROLINA

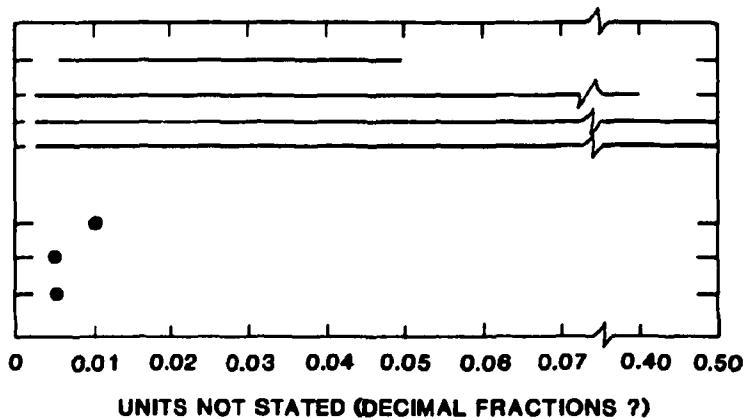


Fig. 9. Porosity (effective).

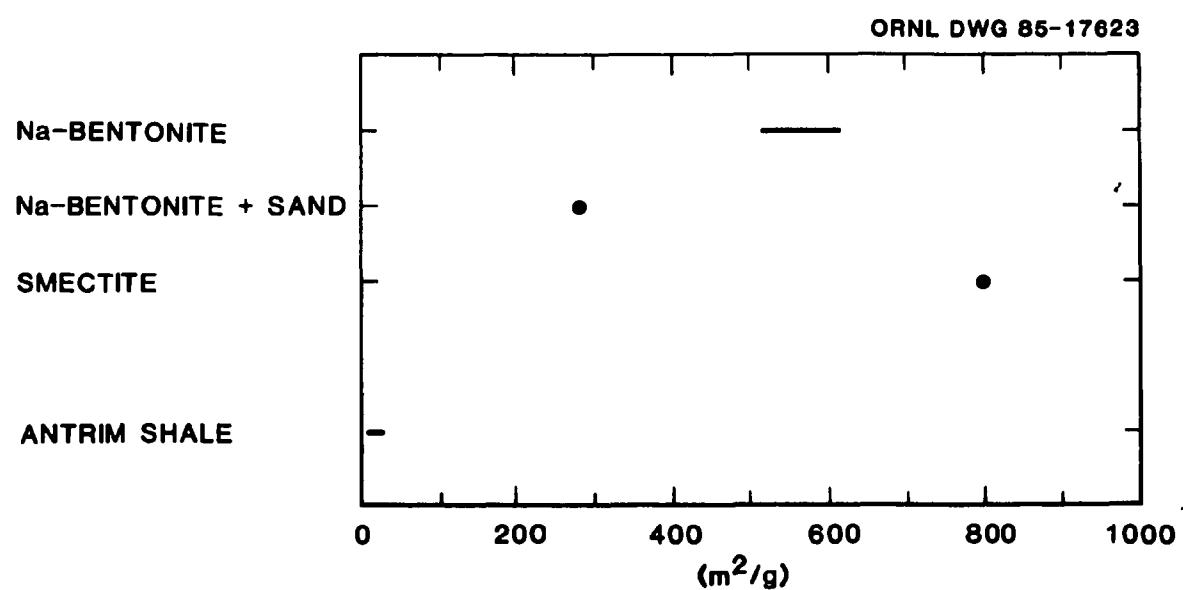


Fig. 10. Specific surface.

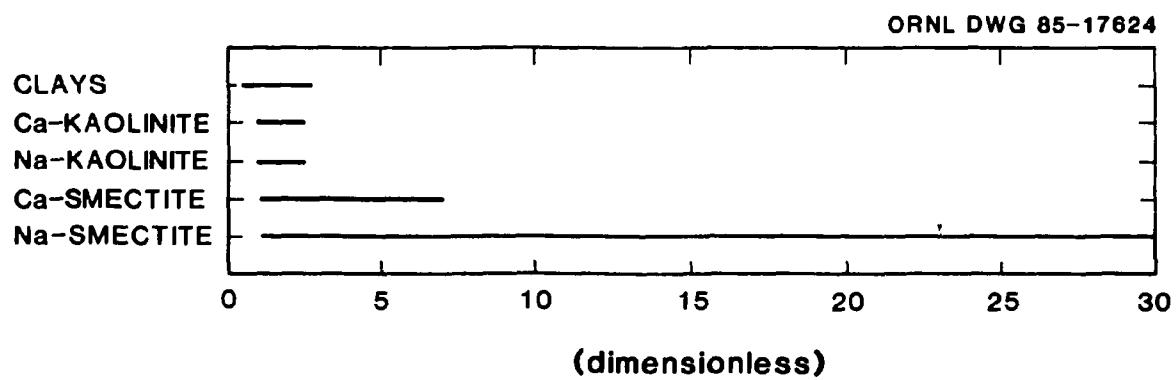


Fig. 11. Void ratio.

are related to density will also change as a function of depth of burial or degree of compaction.

2. We might look for similar relationships with respect to age; that is, older rocks may have greater density and less porosity, and their other properties will be related to these higher or lower values. Preliminary examination of some other property data does not always bear this out; however, the inconsistency in sample collection and test methods is too great to allow us to draw firm conclusions. These relationships are worth exploring as more carefully collected data become available.

In general, most shales have densities between 2.0 and 2.7 g/cm³ (Figs. 3-5); higher or lower values may reflect unusual mineralogical composition, depth of burial, near-surface weathering for samples taken at shallow depths, etc. The data suggest that smectites and (bentonite)-rich materials have slightly lower densities (Figs. 3 and 4). Some of the younger and/or shallower shales and clays also have higher porosity values.

Effective porosity (Fig. 9) is a more important property than either porosity or density; however, it is more difficult to measure and the units reported in the literature are often unclear and inconsistent.

Only limited data were available for "specific surface" (Fig. 10). The few values available suggest that smectite-rich material has much higher values than typical shales.

8.3 HYDROLOGIC PROPERTIES

Several different types of hydrologic properties were recorded in the reports surveyed; however, the information on groundwater travel distance, inflow, specific storage, and travel time was so scant that no interpretation was attempted.

The property that has received the most attention is hydraulic conductivity (and/or permeability, which is directly related to that property). Unfortunately, the lack of uniformity of test methods, experimental conditions, and units used for reporting the results make attempts at interpretation difficult. Most of the available data were determined in an unspecified direction or in the horizontal direction (i.e., parallel to the bedding). Only a few data were reported for the vertical direction. Most workers report vertical conductivity values as much as an order of magnitude

smaller than those in the horizontal direction (i.e., fluids flow through rocks such as shales more rapidly in the horizontal direction than in the vertical direction due to the preferred orientation of the platy clay grains).

All of the hydraulic conductivity and permeability values found in the literature were converted to cm/s. Note that several workers use m/s as well as several other units, including ft/year, m^2 , millidarcies, and microdarcies. A wide range of values was reported. For plotting purposes, the data were divided into two groups for preliminary evaluation. The first group includes rocks (shales, argillites, etc.; see Figs. 12 and 13), while the second group includes clay minerals and mixtures of clays with other materials such as sand (Fig. 14). The data for rocks were divided into "direction unspecified" (Fig. 12) and "horizontal" (Fig. 13).

Interpretation of the plots is difficult because of the many data points and ranges of values for summary data sets. The ever-present uncertainty about the quality of the analyses and unit conversions and the general lack of good mineralogical information about the samples tested (a major uncertainty) also tend to complicate matters.

From the available data, we can identify several relationships:

1. Considering rocks (Figs. 12 and 13), there appears to be a wide range of values from approximately 10^{-12} to $>10^{-6}$ cm/s which do not bear any obvious relationship to age. Values for Paleozoic shales differ by three orders of magnitude. Specific mineralogical data appear to be limited, making it difficult to discern mineralogical trends. The values that have been reported for illite-rich (and presumed illite-rich) rocks are both relatively high and low (e.g., samples of the Antrim Shale range from $\sim 10^{-9}$ to 10^{-6} , and the Conasauga Shale ranges from $\sim 10^{-11}$ to 10^{-9} cm/s). Age and depth of burial may be responsible for the observed differences. The large volume of data available would seem to warrant a closer look, carefully evaluating all of the information concerning sample depth and the conditions under which the hydraulic conductivities were measured. It is important to realize that properties such as hydraulic conductivity can be changed when samples are removed for testing. Field (in situ) testing of the properties of shales is definitely needed.

BLUE CLAY
 BOOM CLAY
 OXFORD CLAY
 PORTERS CREEK CLAY
 CLAYS AND SHALES

 ANTRIM SHALE, MICHIGAN
 (DEVONIAN) (TO 1.9×10^{-6})
 ARNHEIM AND WAYNESVILLE FORMA-
 TIONS (INTACT) (ORDOVICIAN)
 CONASAUGA SHALE (CAMBRIAN)
 MAQUOKETA SHALE (ORDOVICIAN)
 MUDDY SHALE, COLORADO
 (CRETACEOUS) (a)(b)
 PANTHER CREEK FM
 PIERRE, BEARPAW AND CLAGETT
 SHALES (CRETACEOUS)
 PIERRE SHALE (CRETACEOUS) (a)
 PIERRE SHALE (CRETACEOUS) (b)
 SHALE, CALIFORNIA (MIOCENE)
 SHALES, EAST COAST (TRIASSIC)
 SHALES, MICHIGAN AND APPALACHIAN
 BASINS (DEVONIAN)
 SHALES (PALEOZOIC)
 SHALES, ILLINOIS (PALEOZOIC)
 SHALES, MONTANA (PALEOZOIC)
 SHALES, NEW MEXICO (PALEOZOIC)
 SHALES, OKLAHOMA (PALEOZOIC)
 SHALES, TEXAS (PALEOZOIC)
 SHALES, UTAH (PALEOZOIC)
 SHALES (IN SITU)
 SHALES (e)
 SHALES (c)
 SHALES (TO 1.1×10^{-4}) (f)
 SHALE (b)
 TYPICAL ILLITIC SHALE (a)

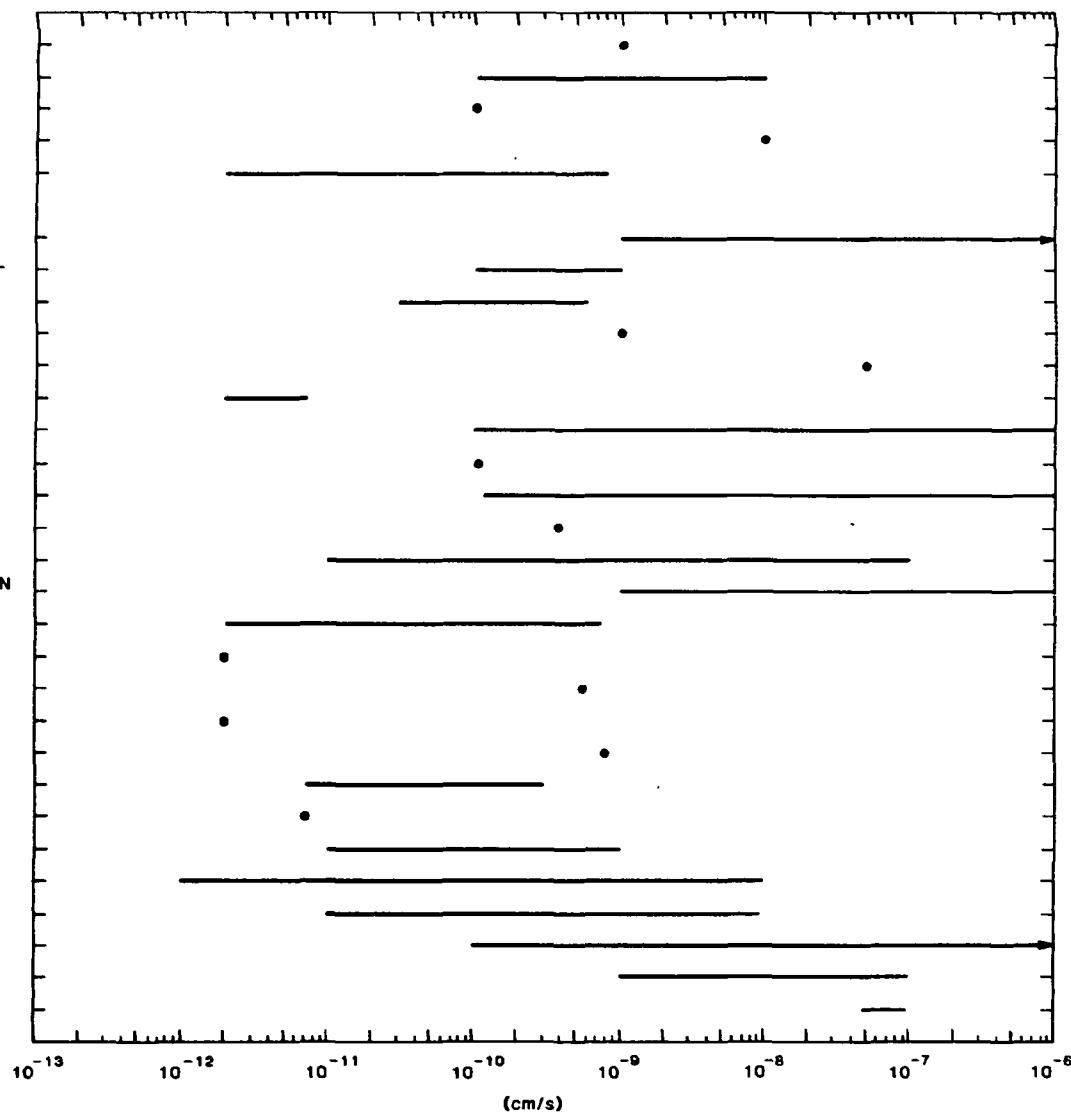


Fig. 12. Hydraulic conductivities for rocks (direction not specified).

ORNL DWG 85-18653

SHALE ADOPTED BASE VALUE
CHAGRIN SHALE (INTACT)
CONASAUGA SHALE (CAMBRIAN)
MAQUOKETA SHALE, ILLINOIS (FIELD)
PIERRE SHALE (FIELD)
PIERRE SHALE (INTACT)
SHALE, MICHIGAN (DEVONIAN)(CORE)
(TO 2×10^{-8})
SHALE, PENNSYLVANIA (DEVONIAN)(CORE)
SHALE, PENNSYLVANIA (DEVONIAN)(FIELD)
SHALE, MARYLAND (TRIASSIC)(FIELD)
SHALE, SOUTH CAROLINA (TRIASSIC)(CORE)
SHALE, SOUTH CAROLINA (TRIASSIC)(FIELD)
SHALE (CORE)(TO 10^{-14}) (b)
SHALE (CORE) (c)
SHALE (a)
SHALE (INTACT)(TO 9.7×10^{-4}) (e)
SHALE (GENERIC)(TO 10^{-4}) (d)
SILTSTONE/MUDSTONE, SOUTH CAROLINA
(TRIASSIC)

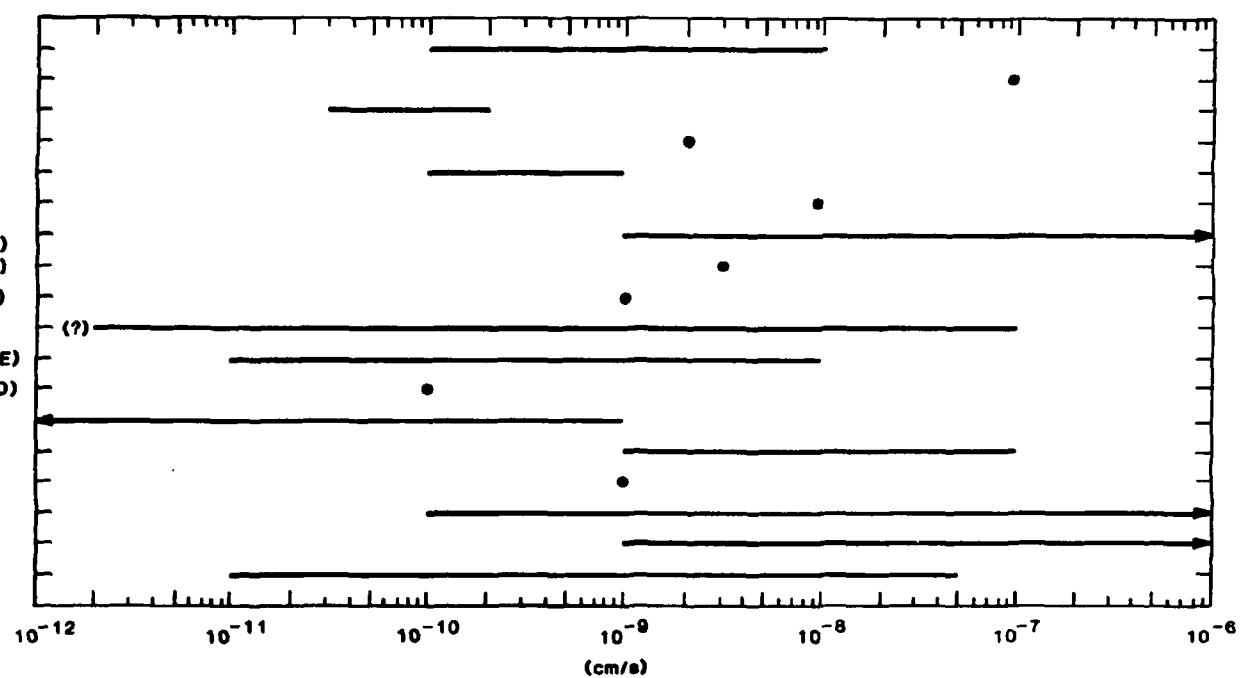


Fig. 13. Hydraulic conductivities for rocks (horizontal).

2. Examination of the data for relatively pure minerals (bentonite samples were included here, and bentonite is considered to be a form of smectite) and mixtures with other materials (Fig. 14) suggests that most smectites have hydraulic conductivities in the range of 10^{-12} to 10^{-11} cm/s, while illites and kaolinites have values that are often $>10^{-10}$. The values for the smectites and bentonites are affected by the degree of compaction, water content, irradiation history, and the extent of mixing with sand and gravel. Mixing with sand and gravel is done to increase thermal conductivity. At the same time, such mixtures tend to have less desirable hydraulic conductivities. The limitations imposed by such inversely related hydraulic and thermal properties will call for a careful balancing act if similar mixtures are used for buffers and backfill.

As a first approximation, it appears that the presence of smectite (and/or bentonite and/or smectitic mixed-layer clays) in shales and related rocks will improve the hydrologic properties of those rocks. At the same time, caution must be exercised because various other mineralogical and physical factors may also have a positive (or a negative) effect on such properties. These factors include the nature of all the minerals present (and not just the clays) and the degree of compaction (including the effective porosity, degree of preferred orientation of the grains, presence of cements, etc.).

All future measurements of hydrologic properties should be made under uniform conditions on carefully selected samples. Field tests will be essential in the selection of any potential sites. Mineralogical analyses should be performed on sample splits.

8.4 MECHANICAL PROPERTIES

Considering the five property groups, mechanical properties have the largest number of different types of measurements and one of the largest sets of data in the Database (Appendix A). Attempts at interpretation were hampered by inconsistencies in the terminology and units used, as well as the lack of information about experimental conditions used for the tests. Individual properties were plotted and are discussed below.

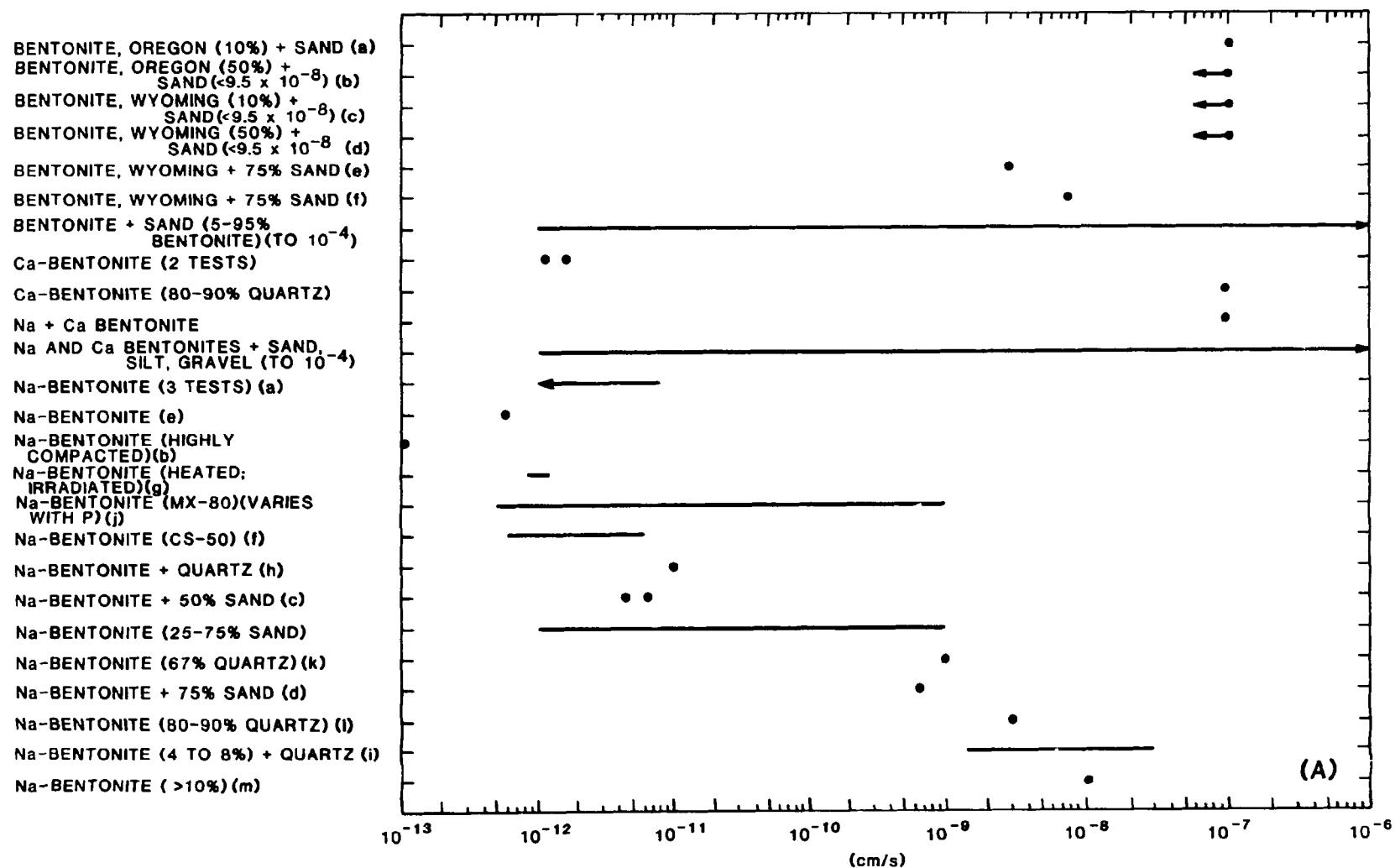


Fig. 14. Hydraulic conductivities (direction not specified) for (A) bentonites and (B) other minerals.

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35

CLAY (RINGOLD)(HANFORD)(50%)
+ SAND
CLAY, SILTY (KNEADING
COMPACTION) (TO 5×10^{-6})
CLAY, SILTY (STATIC
COMPACTION) (TO 5×10^{-6})
Ca-ILLITE (VOID RATIO 0.7 TO 6)
Na-ILLITE (VOID RATIO 0.7 TO 7)
KAOLINITE (a)
KAOLINITE (b)
KAOLINITE (30%) + SAND
Ca-KAOLINITE (VOID RATIO 0.7 TO 2)
(TO 10^{-5})
Na-KAOLINITE (VOID RATIO 0.7 TO 2)
(TO 10^{-5})
Ca-SMECTITE (b)
Ca-SMECTITE (VOID RATIO 1 TO 6) (a)
Ca-SMECTITE (30%) + SAND
Na-SMECTITE (VOID RATIO 1 TO 30) (a)
Na-SMECTITE (30%) + SAND
VOLCLAY SALINE SEAL + 50% SAND

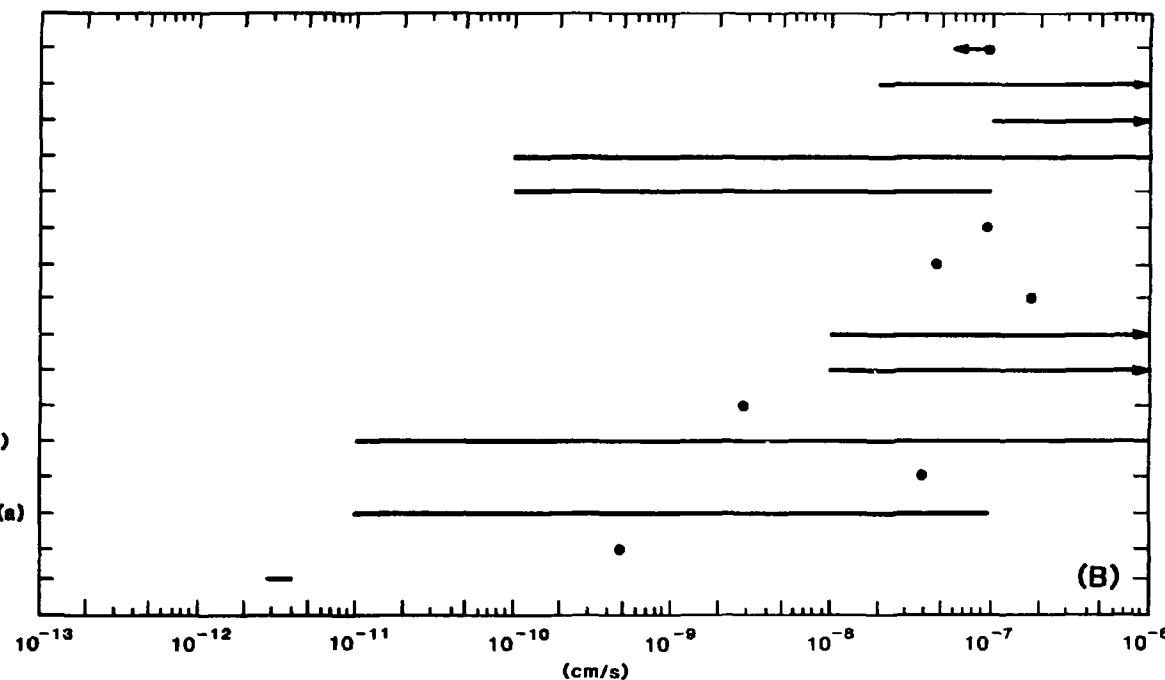


Fig. 14 (Continued).

Only a few sets of data were available for bulk modulus (Fig. 15); however, there appears to be a general increase in the value of bulk modulus with age (and presumably the depth of burial). The of some shales with higher values of bulk modulus than the Eleaite (which had been slightly metamorphosed) needs to be investigate

Cohesion values (Fig. 16) are generally low (<100 MPa). Poorly consolidated materials have lower values than older shales; however, there are inconsistencies in some values (e.g., reported values for the Pierre Shale range over two orders of magnitude), perhaps as a result of the methods used for taking or storing the samples prior to testing.

The values reported for compressive strength (Fig. 17) show a wide variability. An obvious difference is noted when rock values are compared with mineral and mineral mixture values. Older and/or more illitic (relative to more smectite-rich) shales appear to have slightly higher compressive strength values.

The values of friction angle (Figs. 18 and 19) also cover a wide range. In addition, the use of various descriptive modifiers (shear resistance, internal, dilation) makes it difficult to compare the results without further interpretation of the data.

All of the plasticity values (liquid limit, Fig. 20; plastic or plasticity index, Fig. 21; plastic limit, Fig. 22; and shrinkage limit, Fig. 23) are influenced by mineralogy. In fact, these plots provide some of the clearest evidence of mineralogical influence on mechanical properties. The presence of smectite (bentonite) produces large increases in the liquid limit and the plasticity index. Insufficient data were available to interpret the shrinkage limit.

Values of the Poisson's ratio for samples tested (Fig. 24) range from ~0.03 to 0.77. Shales cover most of this range, and there is no obvious relationship to mineralogy.

The data for shear modulus and shear strength (Fig. 25) confirm that shales have much higher values than compacted clays or bentonites. There are some suggestions that older and/or more illitic shales have higher values (to ~10⁶ MPa) of shear modulus.

Swelling and swelling potential (Fig. 26) are influenced by mineralogy. Smectite and/or bentonite swell up to several times as much as illite and kaolinite. Insufficient data were available for swelling distance.

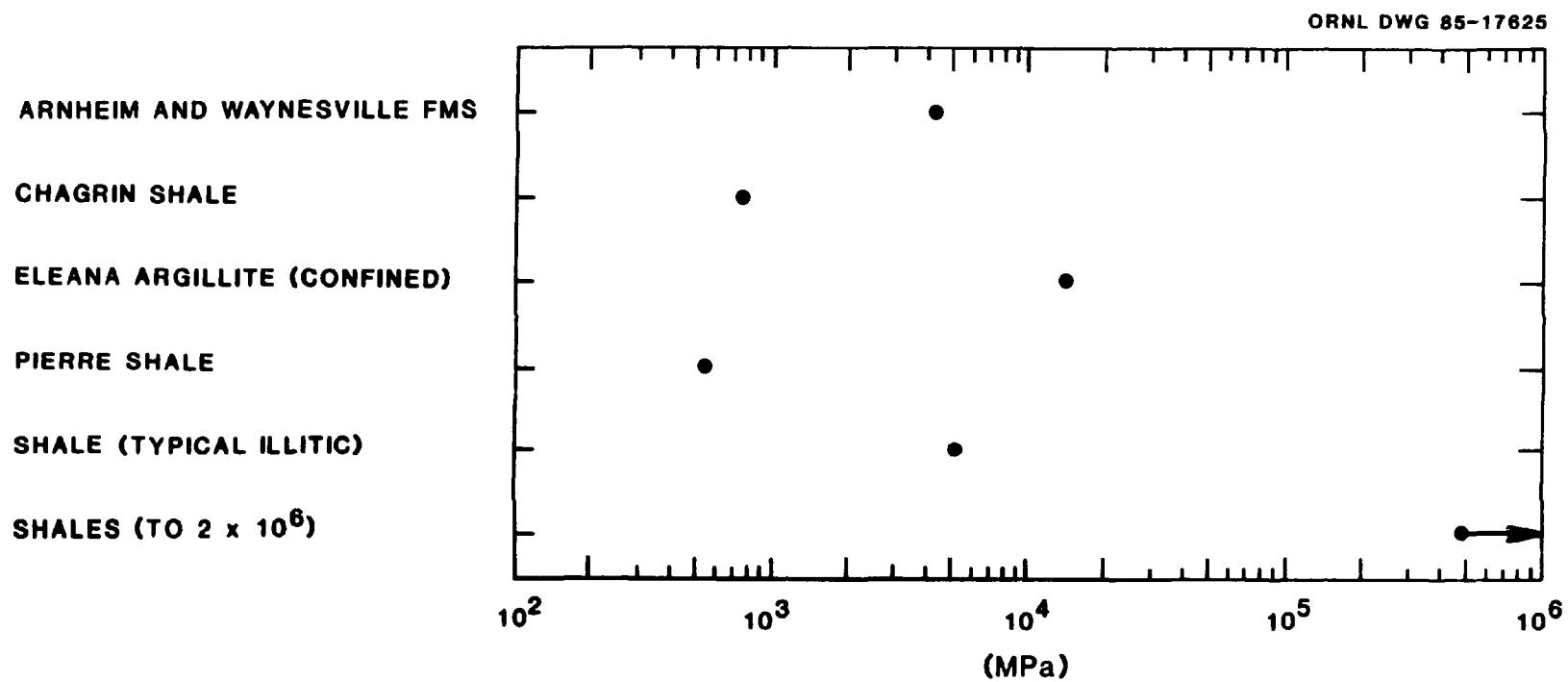


Fig. 15. Bulk modulus.

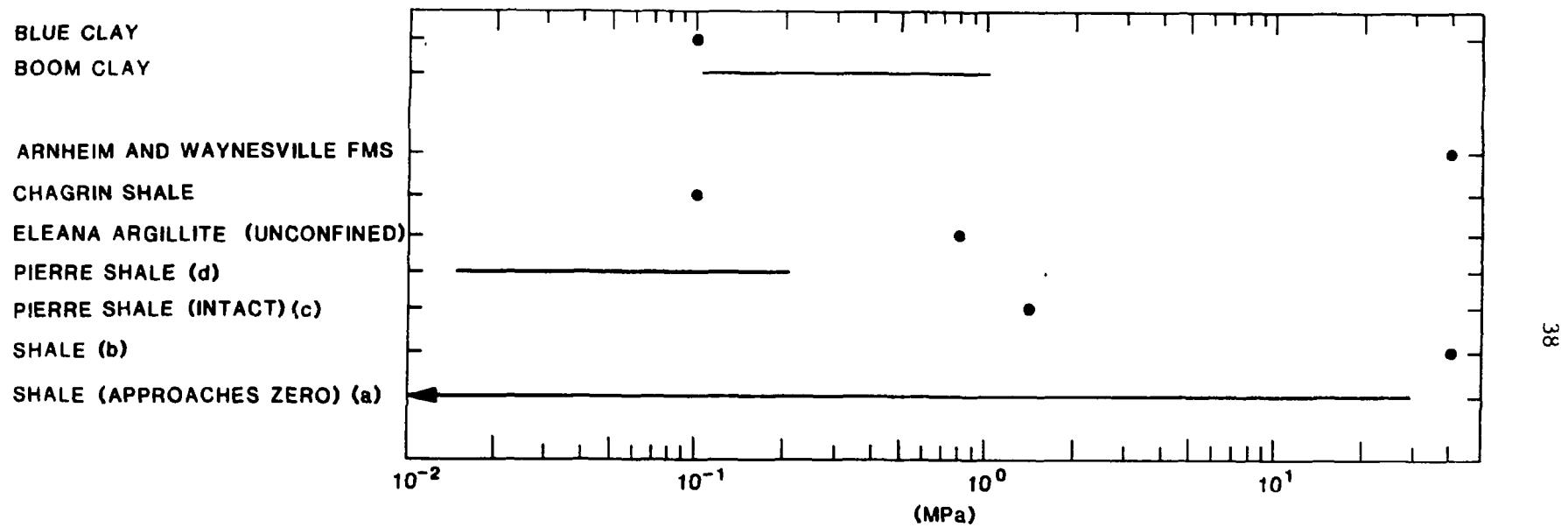


Fig. 16. Cohesion.

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BENTONITE + SAND (a)
 (APPROACHES 0)
 BENTONITE + SAND (b)
 (APPROACHES 0)
 Na-BENTONITE (UNIAXIAL) (b)
 Na-BENTONITE (a)
 KAOLINITE
 Na-SMECTITE, KAOLINITE, SAND (b)
 (TO 6.3×10^{-2})
 Na-SMECTITE, KAOLINITE, SAND (a)
 ARNHEIM AND WAYNESVILLE
 FORMATIONS (UNIAXIAL)
 BEARPAW SHALE, MONTANA (a)
 BEARPAW SHALE, MONTANA (b)
 CHAGRIN SHALE (UNIAXIAL)
 ELEANA (UNCONFINED)
 HUCKNALL SHALE
 LEWIS SHALE, NEW MEXICO
 MANCOS FM, NEW MEXICO
 MAQUOKETA GROUP
 OIL SHALES (LOW GRADE)
 OIL SHALES (HIGH GRADE)
 PIERRE SHALE (b)
 PIERRE SHALE (UNIAXIAL) (a)
 SHALES (UNCONFINED) (a)
 SHALE (UNIAXIAL) (TYPICAL ILLITIC) (b)
 SHALE (UNIAXIAL) (a)
 SHALES, OHIO
 SHALES (UNCONFINED) (b)

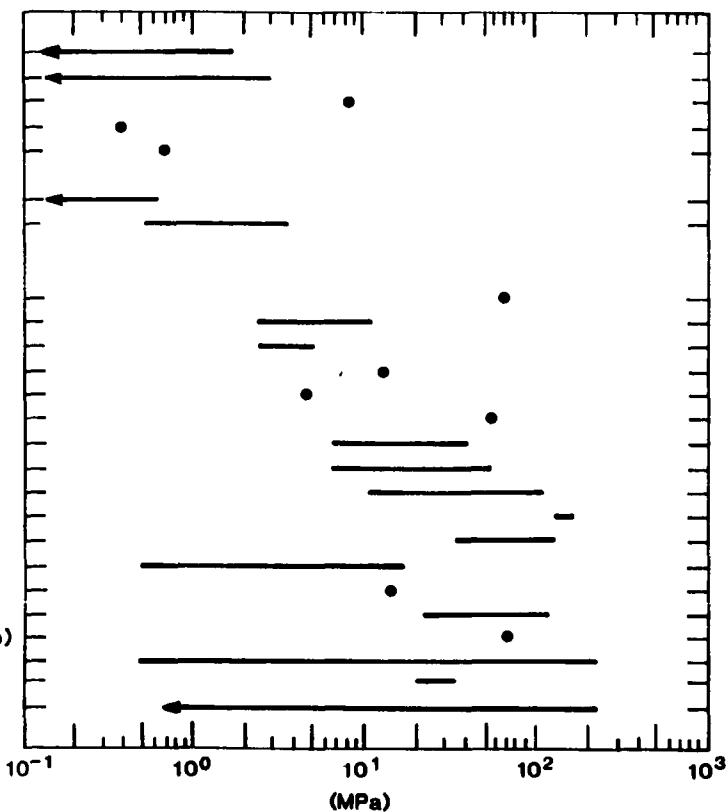


Fig. 17. Compressive strength.

BLUE CLAY (SHEAR RESISTANCE)

BOOM CLAY (SHEAR RESISTANCE)

ARNHEIM AND WAYNESVILLE FMS

CHAGRIN SHALE

ELEANA ARGILLITE (INTERNAL)

PIERRE SHALE (a)

PIERRE SHALE (INTERNAL) (b)

SHALE (a)

SHALE (TYPICAL ILLITIC) (b)

SHALE (DILATION) (c)

SHALE (INTERNAL) (d)

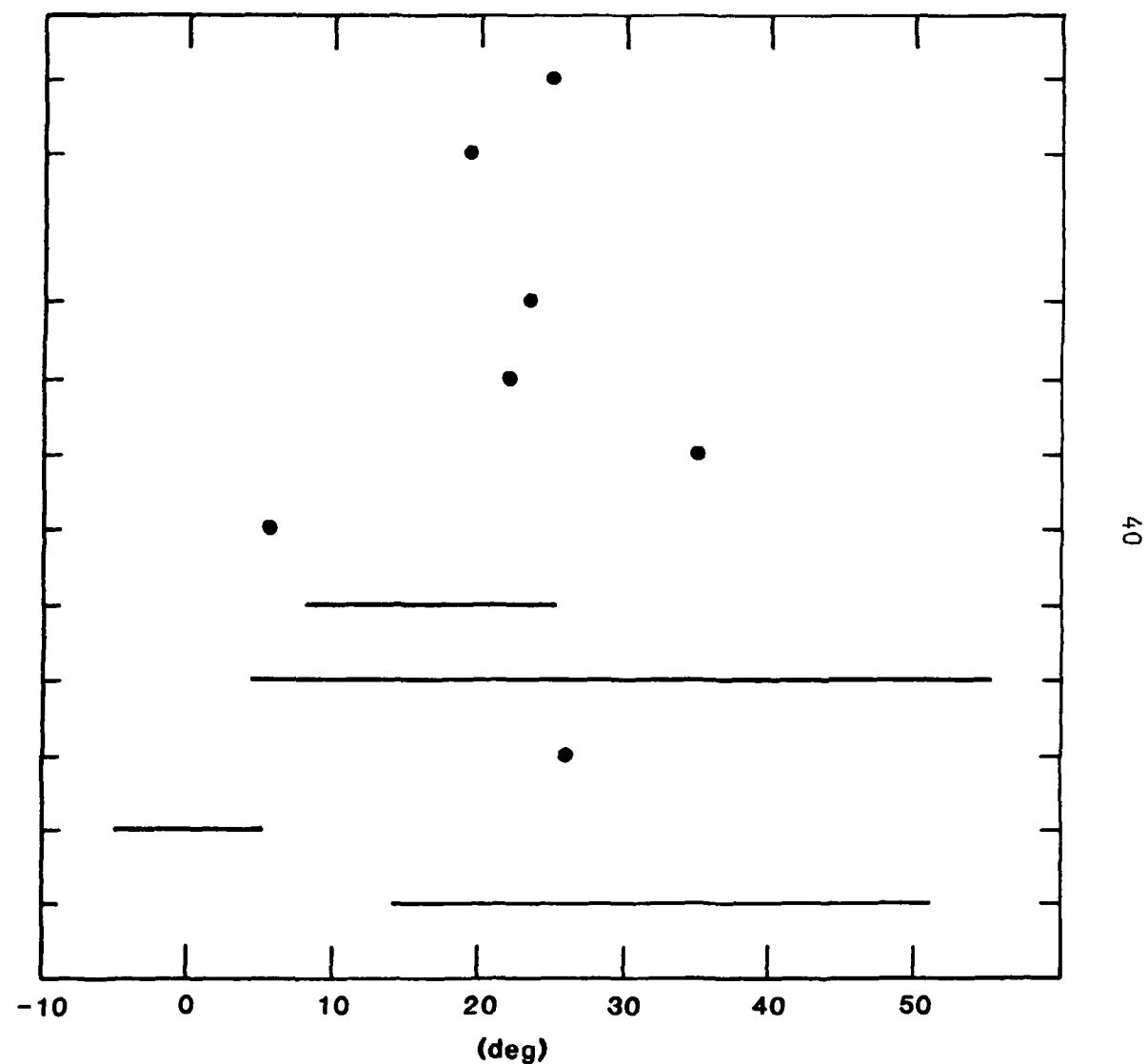


Fig. 18. Friction angle.

ORNL DWG 85-17628

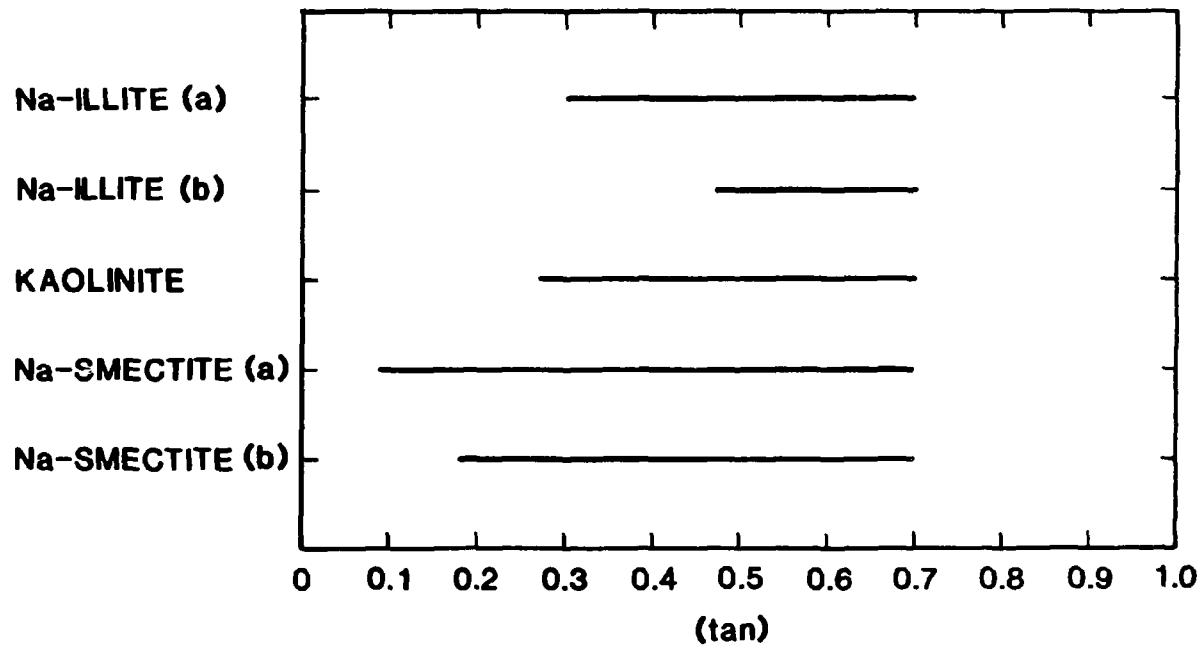


Fig. 19. Friction angle (residual).

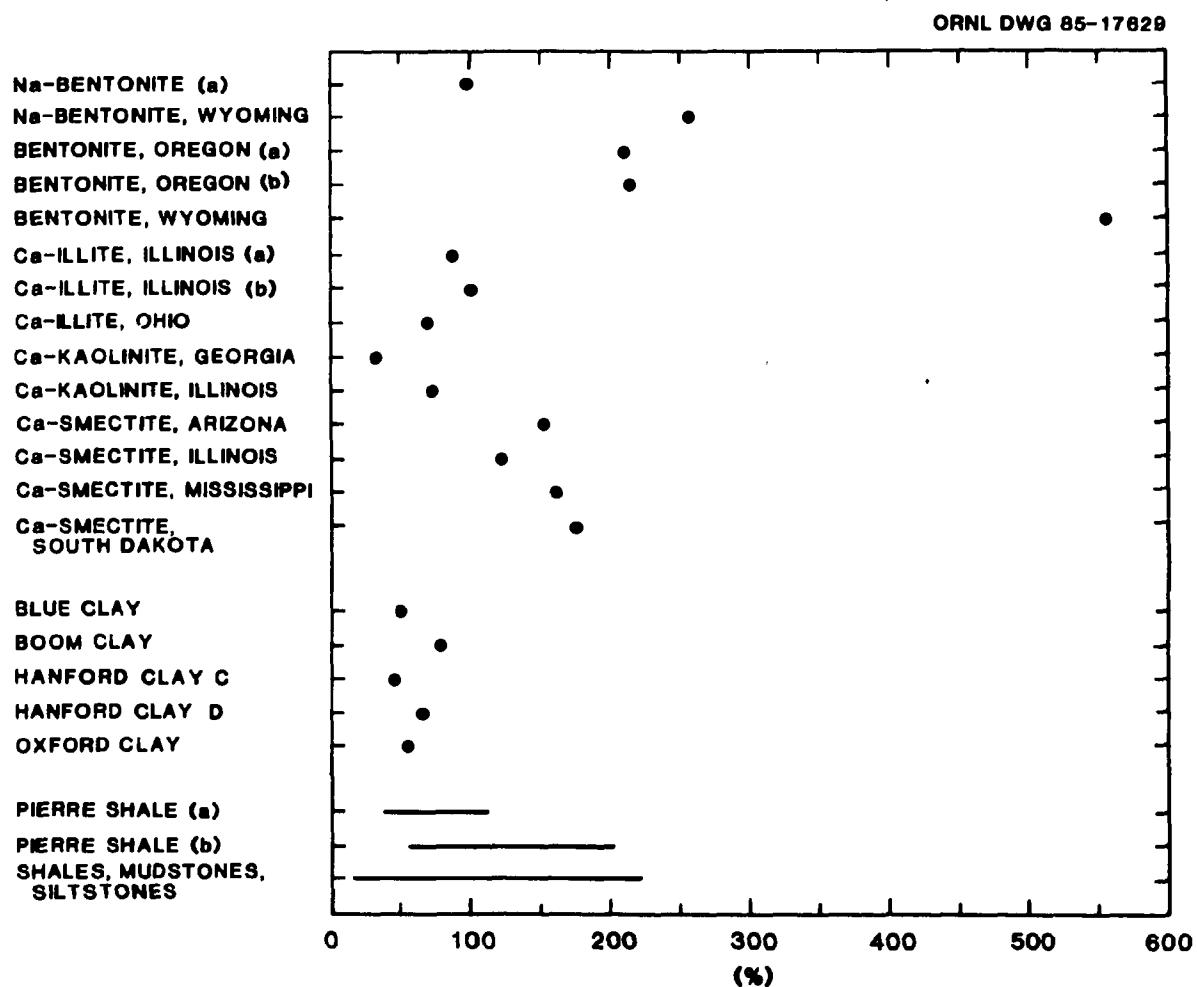


Fig. 20. Plasticity (liquid limit).

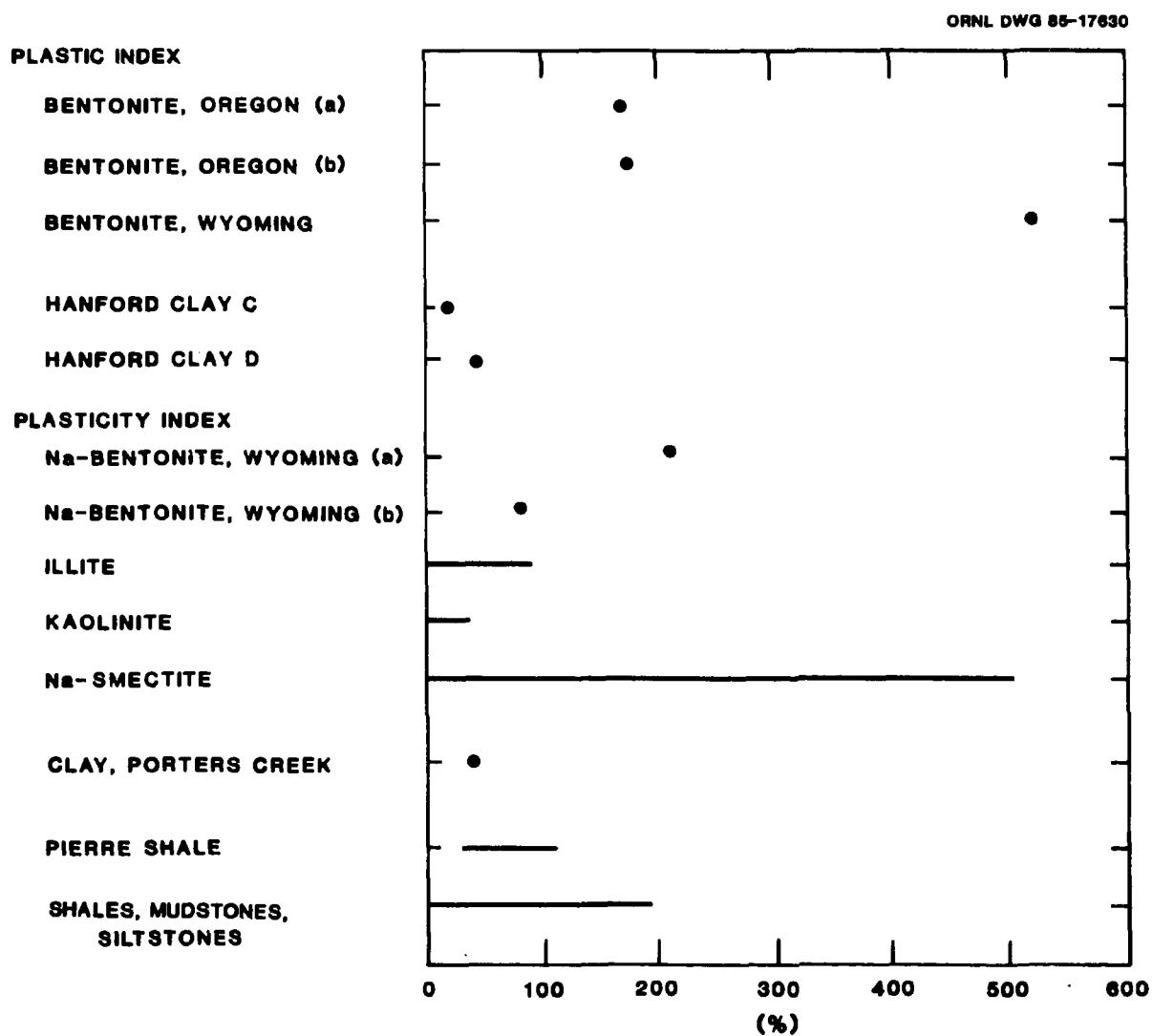


Fig. 21. Plasticity (plastic index, plasticity index).

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Na-BENTONITE, WYOMING (a)
Na-BENTONITE, WYOMING (b)
BENTONITE, WYOMING
BENTONITE, OREGON (b)
BENTONITE, OREGON (a)
Ca-ILLITE, ILLINOIS (a)
Ca-ILLITE, ILLINOIS (b)
Ca-ILLITE, OHIO
Ca-KAOLINITE, GEORGIA
Ca-KAOLINITE, ILLINOIS
Ca-SMECTITE, ARIZONA
Ca-SMECTITE, ILLINOIS
Ca-SMECTITE, MISSISSIPPI
Ca-SMECTITE, SOUTH DAKOTA

BLUE CLAY
BOOM CLAY
HANFORD CLAY C
HANFORD CLAY D
OXFORD CLAY

PIERRE SHALE (a)
PIERRE SHALE (b)
SHALE, SILTSTONES,
MUDSTONES

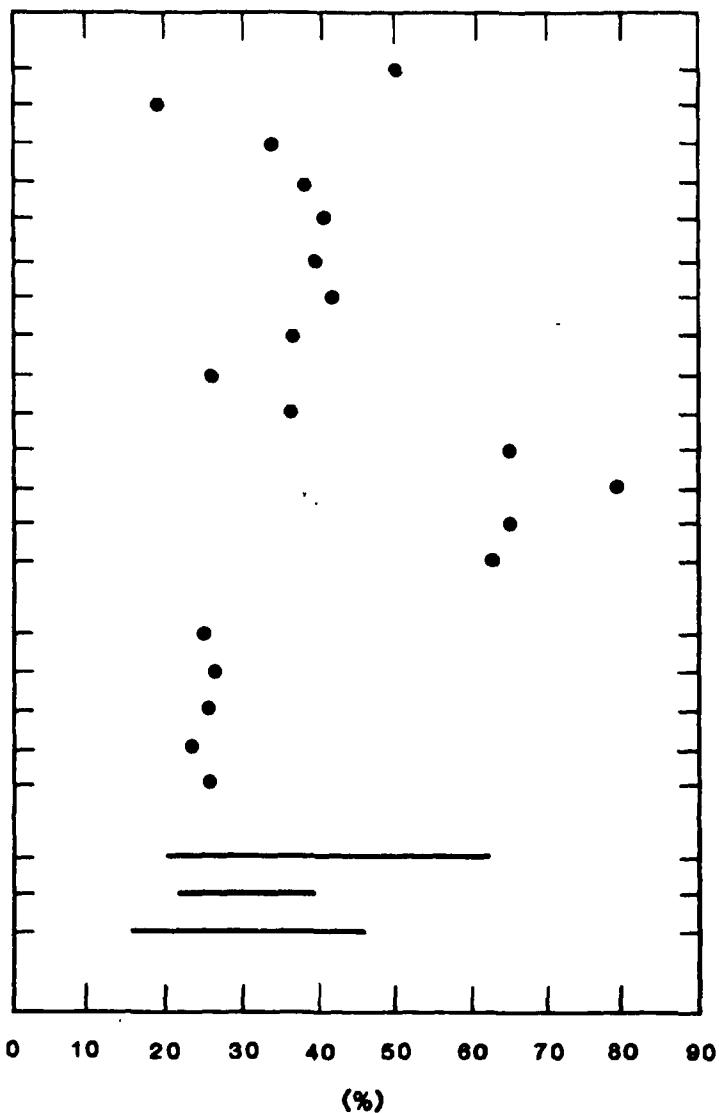


Fig. 22. Plasticity (plastic limit).

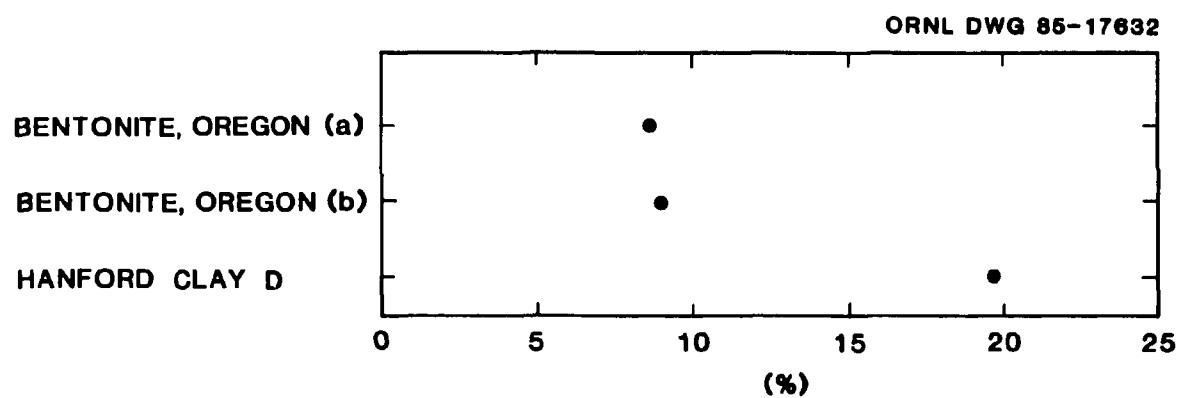


Fig. 23. Plasticity (shrinkage limit).

BENTONITE, WYOMING

ARNHEIM AND
WAYNESVILLE FMS

CHAGRIN SHALE

ELEANA ARGILLITE

OIL SHALES (LOW GRADE)

OIL SHALES (HIGH GRADE)

PIERRE SHALE

SHALE (TYPICAL ILLITIC) (b)

SHALE (a)

SHALE (a)

SHALE (b)

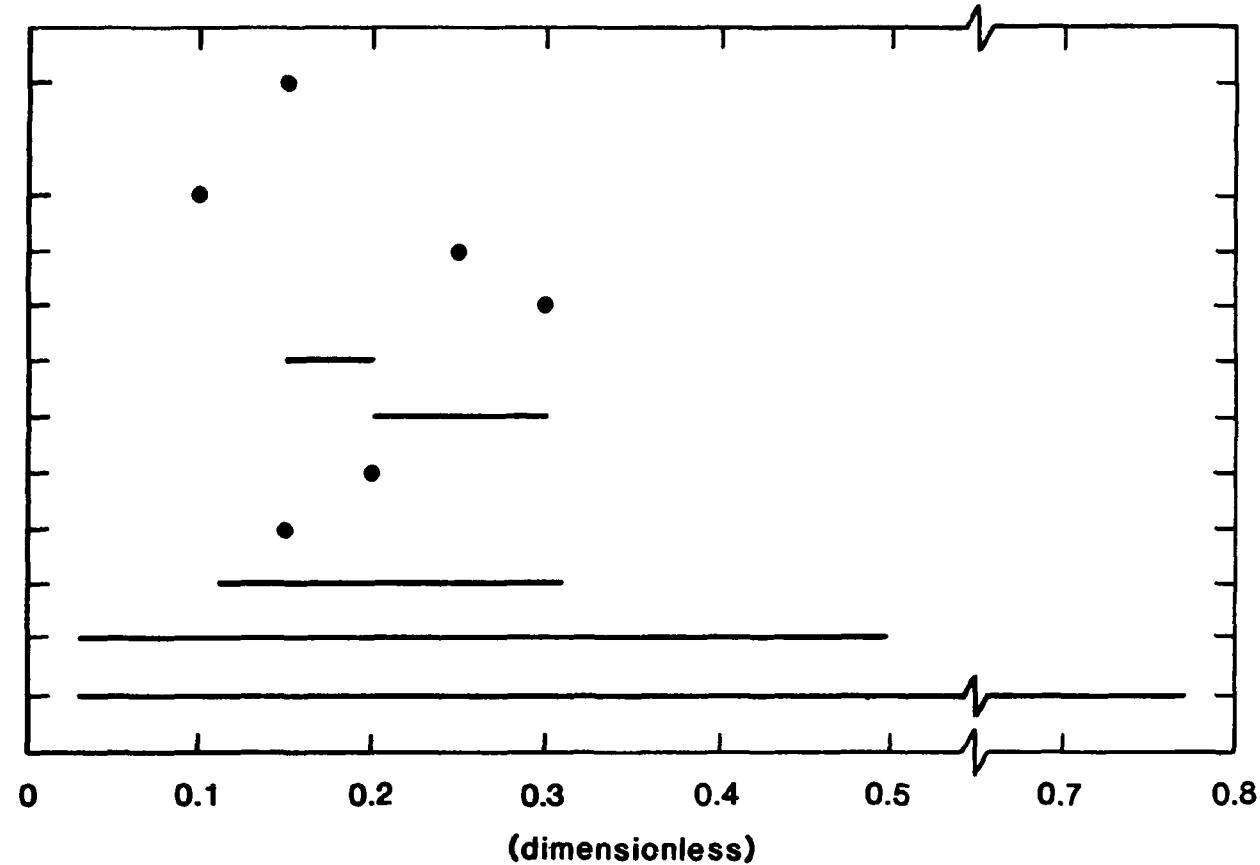


Fig. 24. Poisson's ratio.

Na-BENTONITE (SHEAR
 STRENGTH)(TO 1.5×10^{-2})(a)
 Na-BENTONITE (SHEAR STRENGTH) (b)

 BLUE CLAY (SHEAR STRENGTH)
 BOOM CLAY (SHEAR
 STRENGTH)(0.6)
 OXFORD CLAY (SHEAR STRENGTH)
 PORTERS CREEK CLAY (STRENGTH
 NOT SPECIFIED)(0.19)

 ARNHEIM AND WAYNESVILLE
 FORMATIONS (INTACT)
 CHAGRIN SHALE (INTACT)
 PIERRE SHALE (INTACT)
 SHALES (0-6000') (TO 1×10^6)(a)
 SHALES, VARIOUS (b)
 TYPICAL ILLITIC SHALE (INTACT)

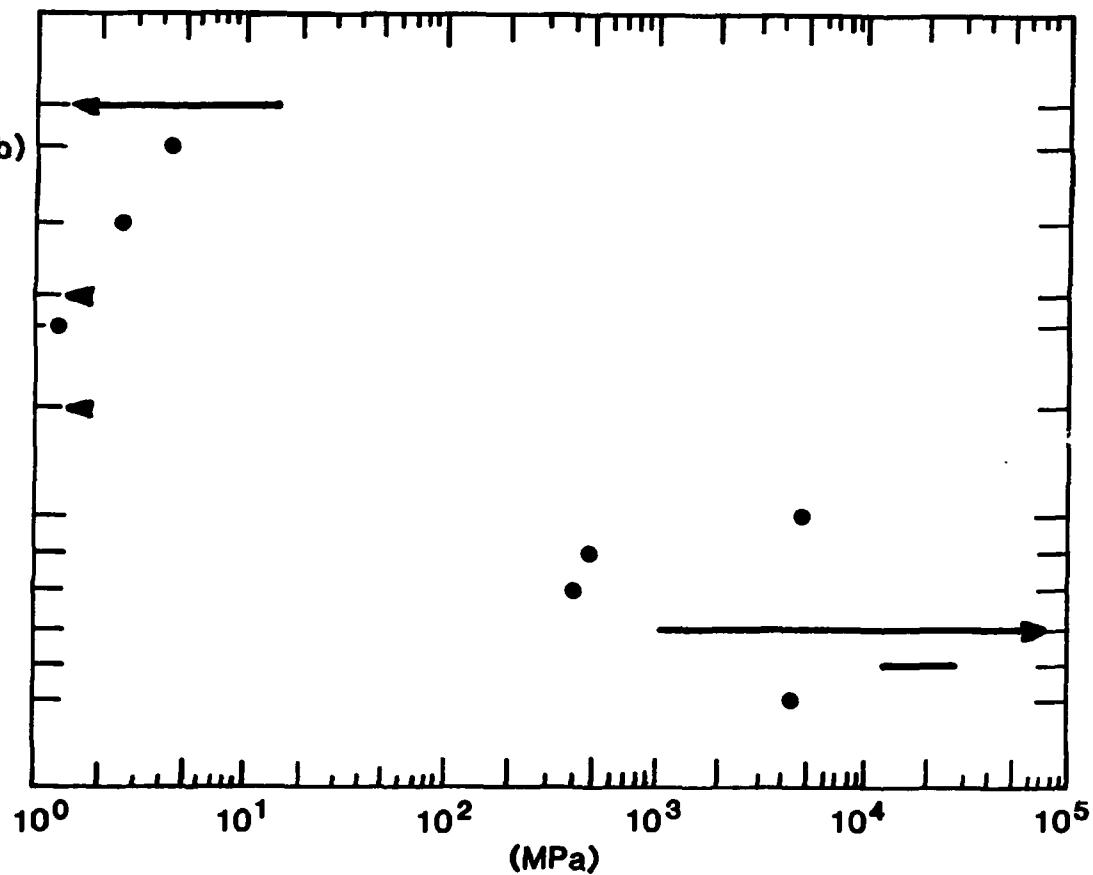


Fig. 25. Shear modulus and shear strength.

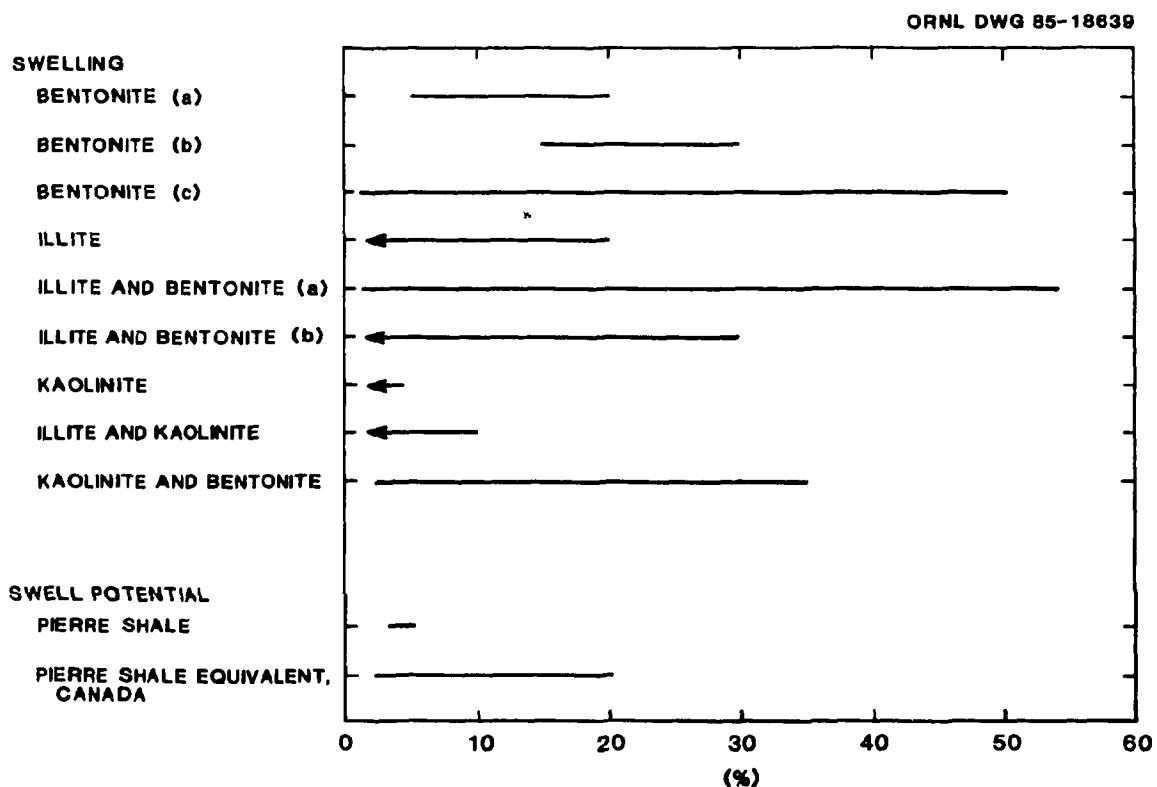


Fig. 26. Swelling and swell potential.

Most of the measurements for swelling pressure (Fig. 27) were made for smectite (bentonite)-rich samples. Swelling pressure decreased when sand was added. The value determined for a shale sample is also relatively low.

A few values were found for tensile strength (Fig. 28). Values for shales ranged up to 10 MPa, but the data were insufficient to establish any trends.

Young's (elastic) modulus values (Fig. 29) range from ~ 10 to 10^6 MPa. The values for older, more illitic shales appear to be higher than for shales like the Pierre, the Boom and Blue Clay, and bentonite-sand mixtures.

Overall, the mechanical properties appear to be influenced by the clay mineral content of the material tested. In general, the older, and typically more illitic, rocks that have been slightly metamorphosed possess greater strength.

8.5 THERMAL PROPERTIES

Only a limited number of types of thermal properties were found in the reports reviewed. These include the coefficient of linear (thermal) expansion, heat capacity and specific heat (capacity), thermal (heat) conductivity, and thermal diffusivity.

A plot of the coefficients of linear thermal expansion (Fig. 30) reveals that most values are for shales and typically fall into the range from ~ 2 to $16 \text{ K}^{-1} \times 10^{-6}$. No trends were obvious; however, no values were found for smectite-rich samples.

The plots for heat capacity and specific heat (capacity) (Fig. 31) show that the values fall in a very narrow range from $\sim 5 \times 10^2$ to $1.2 \times 10^3 \text{ J/kg}\cdot\text{K}$. Again, the sample compositions were very limited, and no trends could be seen. Two values for the Blue and Boom Clays fall in the typical range for the shales tested.

The greatest volume of data was available for thermal conductivity (or heat conductivity) (Fig. 32). The most obvious distinction was found between rock samples and mineral samples and/or soils; the values for some soils are lower by as much as an order of magnitude. Some other trends could also be established. The measurements (for a set of related samples) showed a gradual increase in thermal conductivity with increasing sample

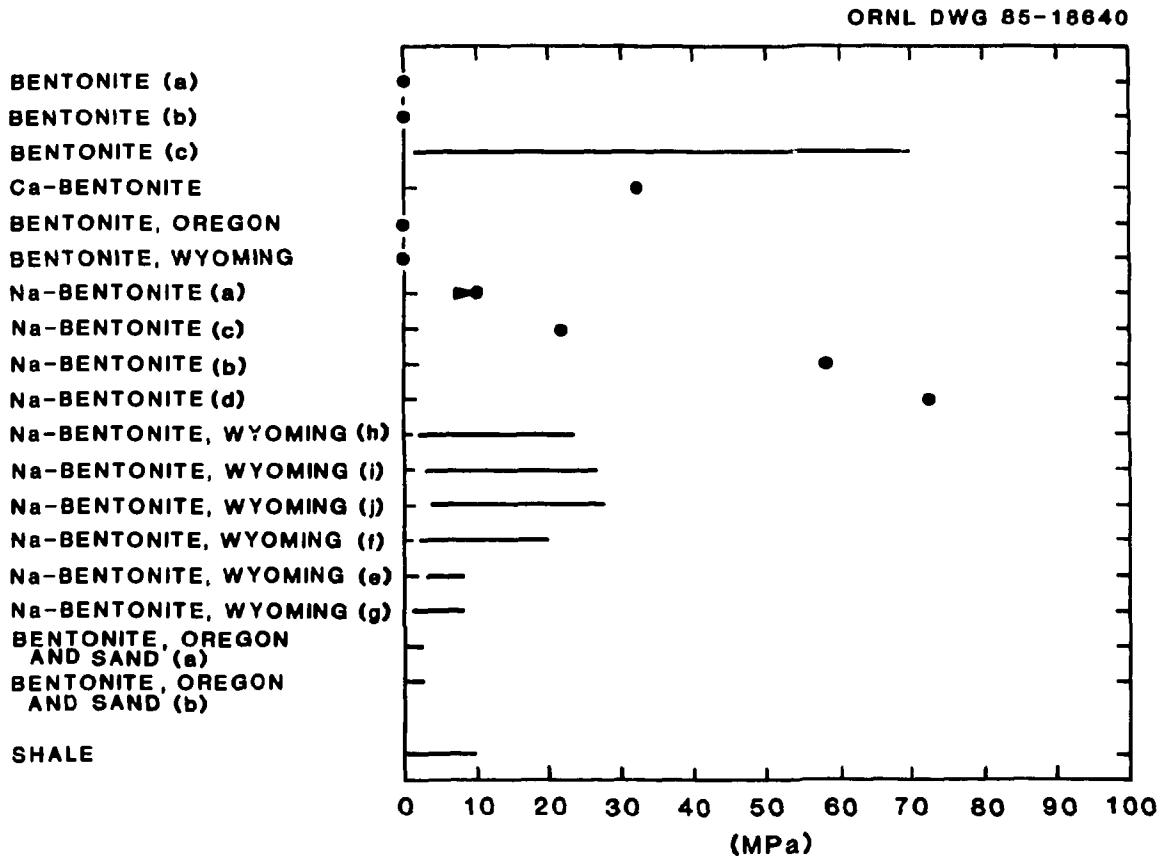


Fig. 27. Swelling pressure.

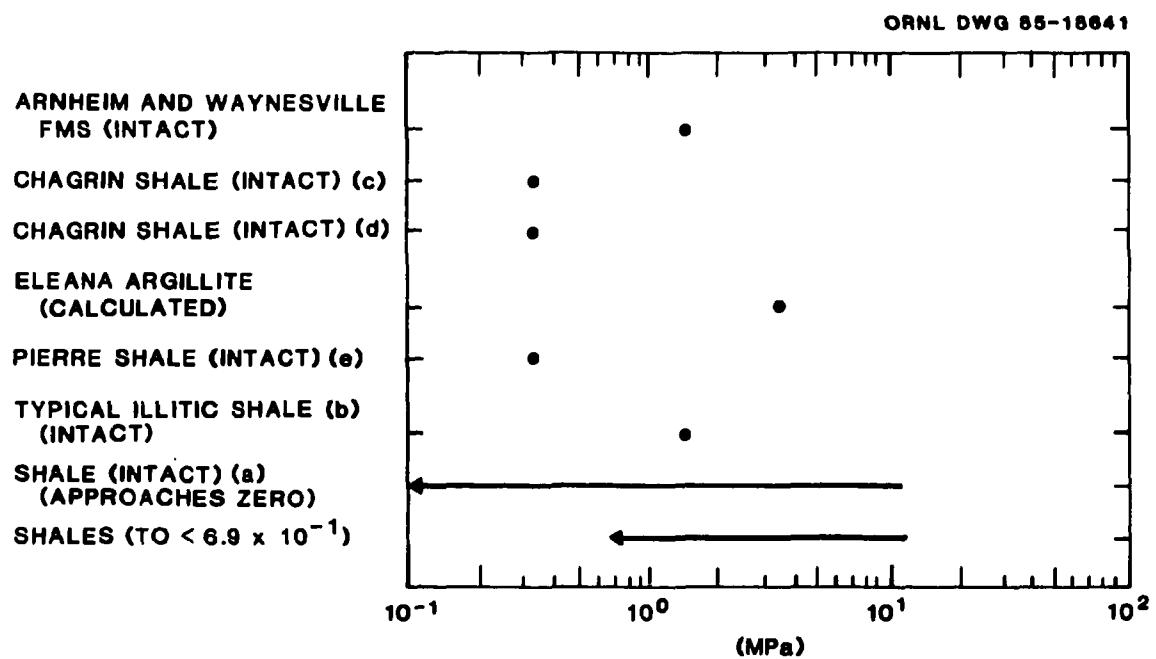


Fig. 28. Tensile strength.

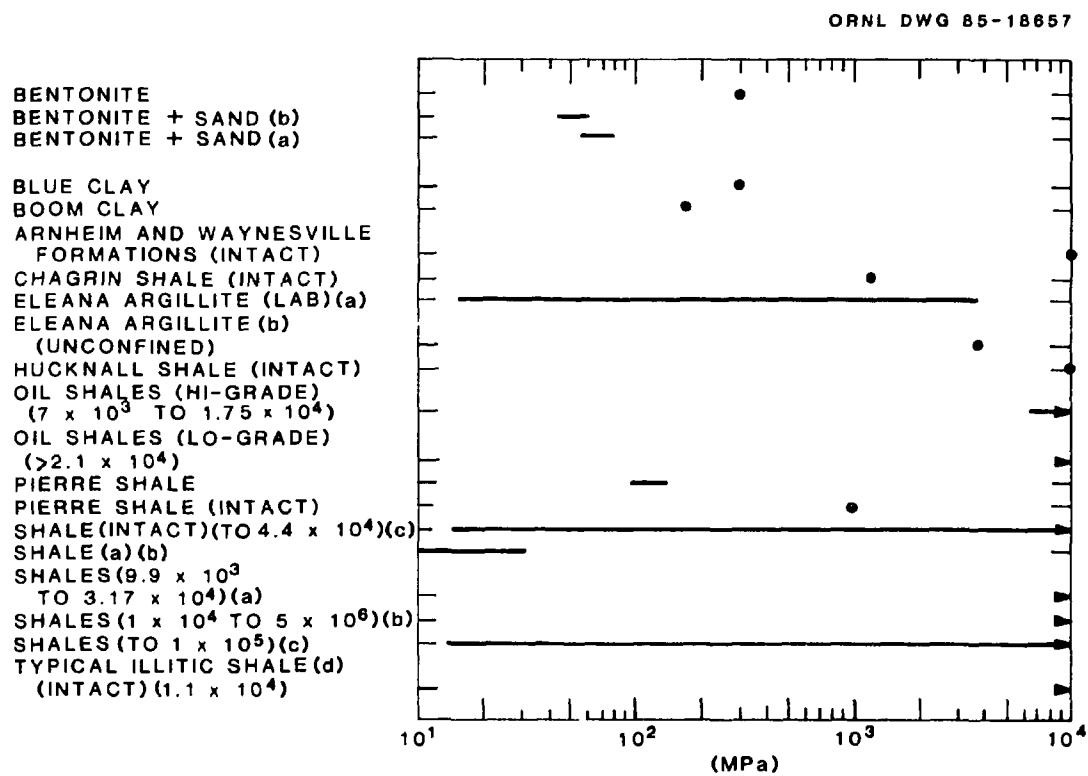


Fig. 29. Young's (elastic) modulus.

ORNL DWG 85-18642

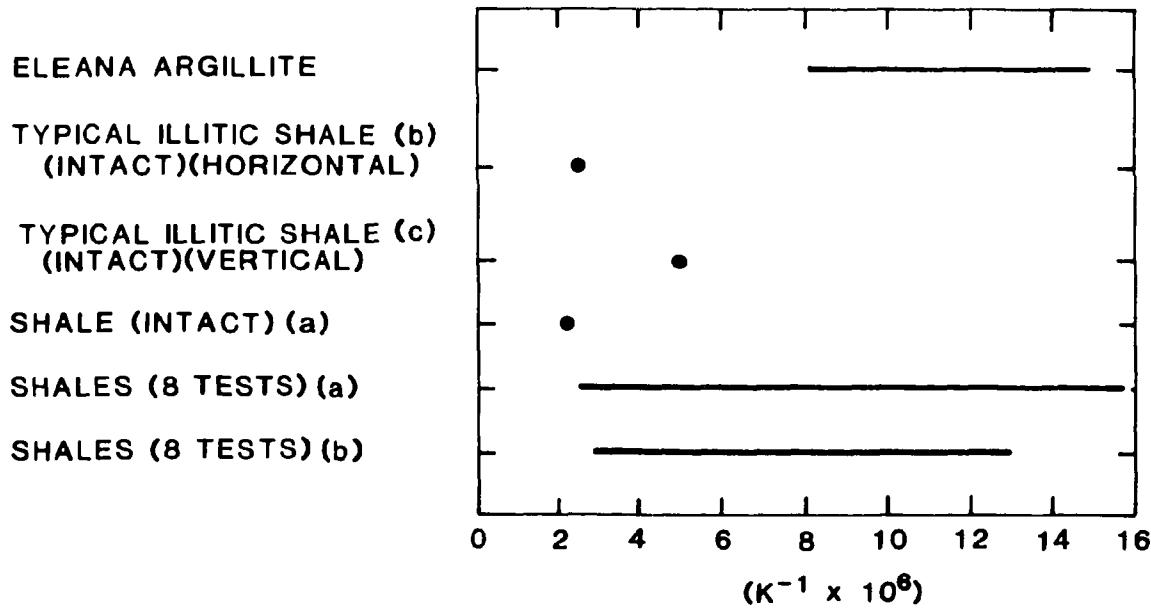


Fig. 30. Coefficient of linear (thermal) expansion.

ORNL DWG 85-18643

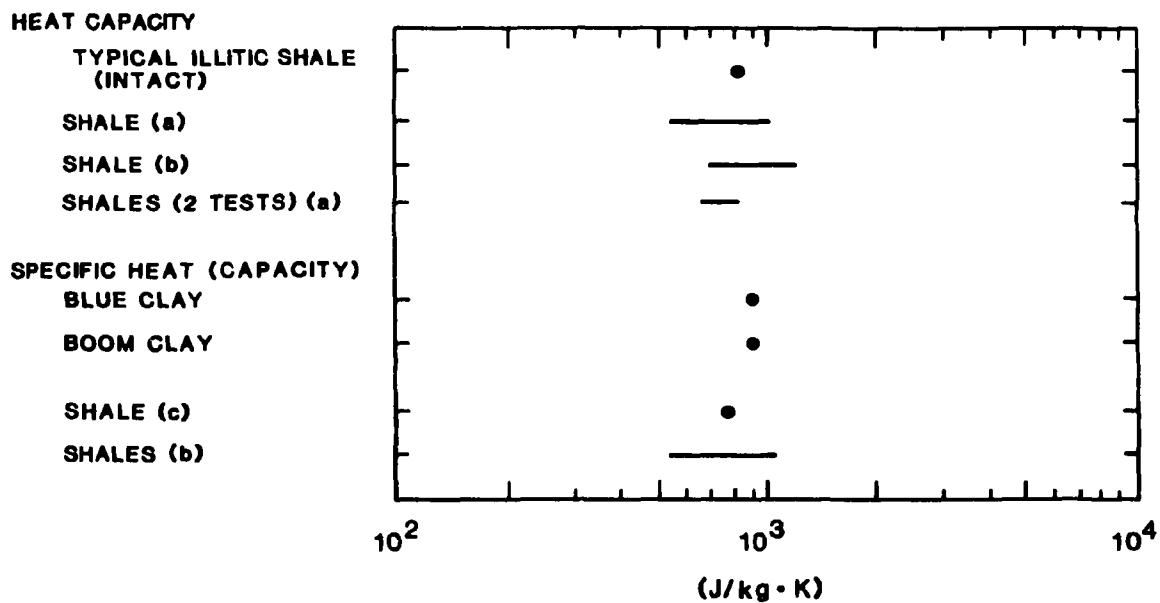


Fig. 31. Heat capacity and specific heat (capacity).

density. In almost every case where the amounts of water were known, the thermal conductivity increased as the water content increased. Thermal conductivities also appeared to increase as the nonclay (sand, granite, etc.) fraction was increased. Most thermal conductivities for clay-rich rocks fall within the range from ~0.5 to 3 W/m·K, although a few higher values were recorded.

Only a few values for thermal diffusivity (Fig. 33) were available for some soils, a sodium bentonite, and the Blue and Boom Clays. The latter two materials had the highest values of the group.

The ranges for thermal properties appear to be narrower, in general, than those for mechanical properties; however, the difference between 0.5 and 3 W/m·K could be quite significant when trying to determine the thermal loading of a repository. The effect of clay mineral composition may be overshadowed by the amount of quartz present (often the most abundant mineral in shales), the amount of moisture present (the most common pore fluid in shales), and/or the degree of packing of the constituent grains in the rock. The weight percent of quartz in a shale might be important as an indicator of its thermal conductivity.

9. COMPARISON OF SELECTED PROPERTIES FOR SOME SPECIFIC FORMATIONS

In some cases, formations were identified in the reports that were used in this study, and some information about their mineral compositions were reported in a few cases. Additional data of this type may be available in the original references. Information concerning the Conasauga Shale, some Devonian Shales (e.g., the Antrim and the Chagrin), and the Pierre Shale (with lesser information on the Eleana Argillite, some "oil shales," and shales that were identified as "typical illitic shales") was plotted for the following properties: hydraulic conductivity (Fig. 34), bulk modulus (Fig. 35), cohesion (Fig. 36), compressive strength (Fig. 37), shear modulus (Fig. 38), tensile strength (Fig. 39), Young's (elastic) modulus (Fig. 40), and thermal conductivity (Fig. 41). The results, which are discussed below, should be considered preliminary and used with caution because (1) the data available for plotting each figure is rather limited,

BENTONITE, WYOMING (DRY)(10 TESTS)(d)
 BENTONITE, WYOMING (WET)(10 TESTS)(c)
 BENTONITE, WYOMING (APPROACHES ZERO)
 BENTONITE (b)
 BENTONITE (5-16% WATER) (f)
 BENTONITE, WYOMING (66% SATURATED) (h)
 BENTONITE (100% SATURATED) (e)
 BENTONITE (30:70 BENTONITE:SALT)(a)
 BENTONITE (30:70 BENTONITE:SALT)(b)
 BENTONITE, WYOMING AND CRUSHED GRANITE (a)
 BENTONITE AND CRUSHED GRANITE (b)
 BENTONITE AND SAND (DRY) (b)
 BENTONITE AND SAND (5-30% WATER) (a)
 BENTONITE AND 90% QTZ (a)
 Ca-BENTONITE
 Na-BENTONITE
 HECTORITE AND 90% QTZ (DRY TO SATURATED)
 ILLITE (SEAL BOND)(a)
 ILLITE (SEAL BOND) AND SAND, ETC., (DRY)(c)
 ILLITE (SEAL BOND) AND SAND, ETC., (MOIST)(b)
 ILLITE (50:50 SEAL BOND, GRANITE)(0-10 % MOISTURE)
 KAOLOWITE AND SAND, ETC., (MOIST) (a)
 KAOLOWITE AND SAND, ETC., (DRY) (b)
 KAOLOWITE AND GRANITE

 BLUE CLAY
 BOOM CLAY (b)
 BOOM CLAY (MATRIX)(a)
 OXFORD CLAY
 CLAY (S. PAOLO MINE)

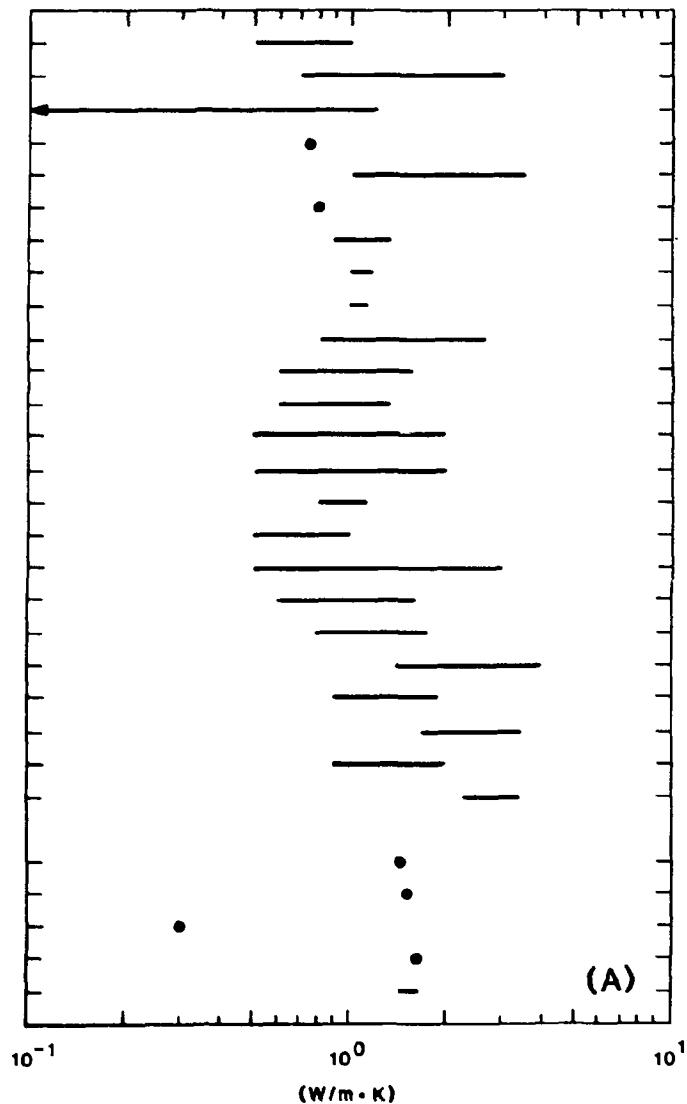


Fig. 32. Thermal (heat) conductivity for (A) bentonites and clays and (B) soils and shales.

SILT/CLAY SOIL (a)
 SILT/CLAY SOIL (b)
 SILT/CLAY SOIL (c)
 SILT/CLAY SOIL (d)
 SILT/CLAY SOIL (e)
 SILT/CLAY SOIL (f)
 CONASAUGA SHALE (m)
 CONASAUGA SHALE (MATRIX) (i)
 ELEANNA ARGILLITE (c)
 ELEANNA ARGILLITE (MATRIX) (a)
 ELEANNA ARGILLITE (VERTICAL) (b)
 KAROO SHALE
 NONE SUCH SHALE
 PIERRE SHALE
 CLAYEY SANDSTONES
 SHALES, CALIFORNIA
 SHALE, KANSAS
 SHALE, MASSACHUSETTS (k)
 SHALE, MASSACHUSETTS (j)
 SHALE, ENGLAND (CARBONIFEROUS) (h) (i)
 SHALE, ENGLAND, (TRIASSIC) (5 TESTS) (a)
 SHALE, SOUTH AFRICA
 SHALE (HORIZONTAL) (d)
 SHALE (HORIZONTAL) (c)
 SHALE (VERTICAL) (i)
 SHALES (HORIZONTAL) (a)
 SHALES (b)
 TYPICAL ILLITIC SHALE (n)
 TYPICAL ILLITIC SHALE (INTACT) (HORIZONTAL) (b)
 TYPICAL ILLITIC SHALE (VERTICAL) (e)

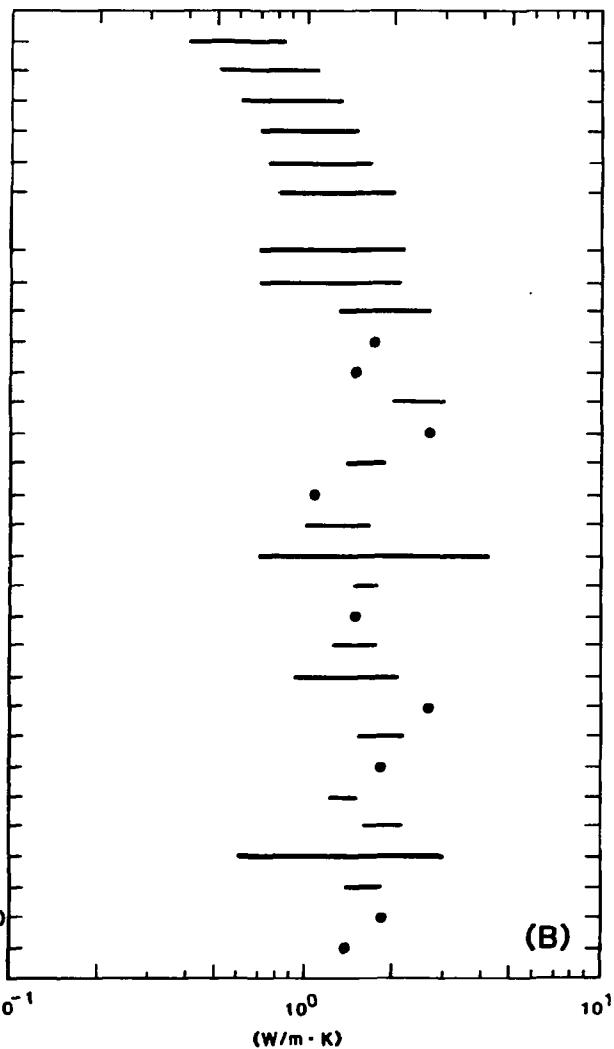


Fig. 32 (Continued).

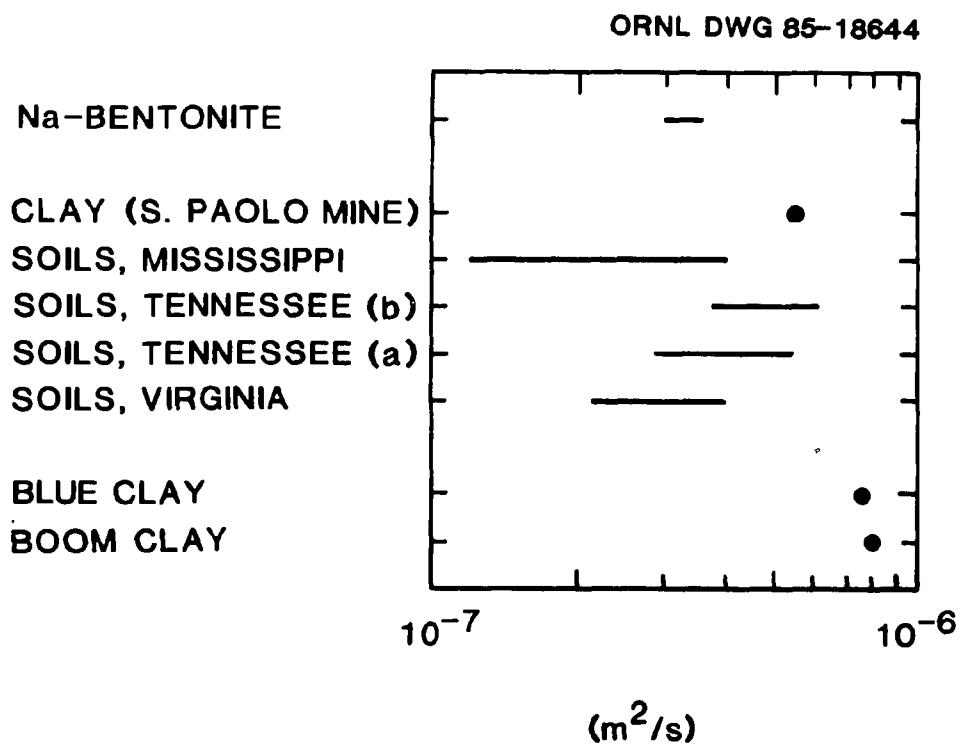


Fig. 33. Thermal diffusivity.

ORNL DWG 85-18662

CONASAUGA SHALE
CONASAUGA SHALE (CORE)
(HORIZONTAL)

DEVONIAN SHALE (ANTRIM)
MICHIGAN (TO 1.9×10^{-6})

DEVONIAN SHALE (CHAGRIN)
(HORIZONTAL)(INTACT) (10^{-7})

DEVONIAN SHALE (CHAGRIN)
(VERTICAL)(INTACT) (5×10^{-8})

DEVONIAN SHALE, MICHIGAN
(HORIZONTAL)(CORE)(TO 2×10^{-6})

DEVONIAN SHALE, MICHIGAN,
APPALACHIAN BASINS (TO 10^{-6})

DEVONIAN SHALE, PENNSYLVANIA
(HORIZONTAL)

DEVONIAN SHALE, PENNSYLVANIA
(FIELD TEST)

PIERRE, BEARPAW AND
CLAGGETT SHALES (TO 10^{-6})

PIERRE SHALE

PIERRE SHALE (FIELD TEST)

PIERRE SHALE (HORIZONTAL)

PIERRE SHALE (VERTICAL)

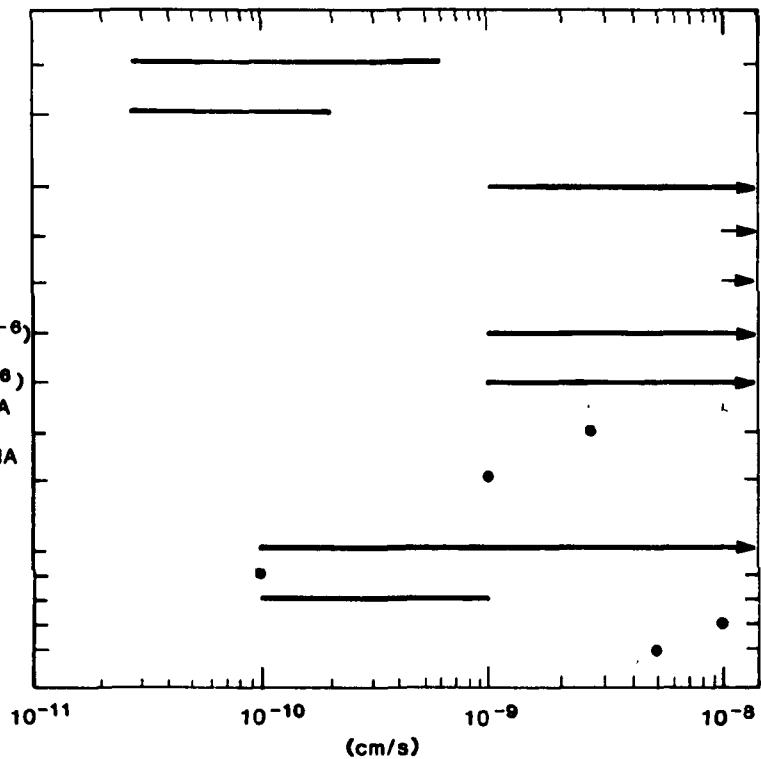


Fig. 34. Hydraulic conductivity for selected samples.

ORNL DWG 85-18661

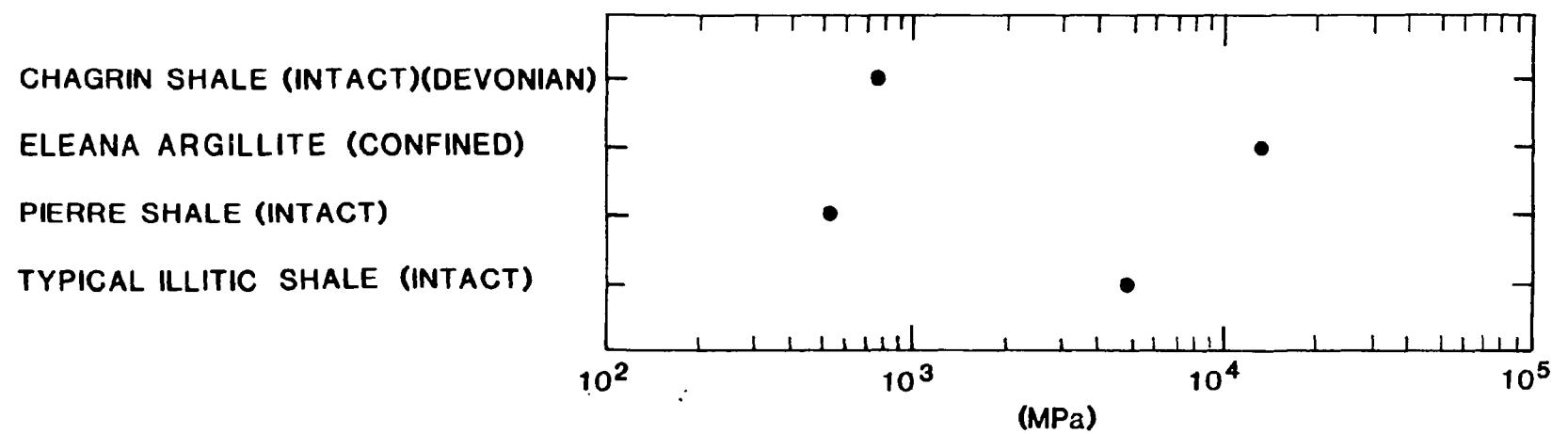


Fig. 35. Bulk modulus values for selected samples.

ORNL DWG 85-18660

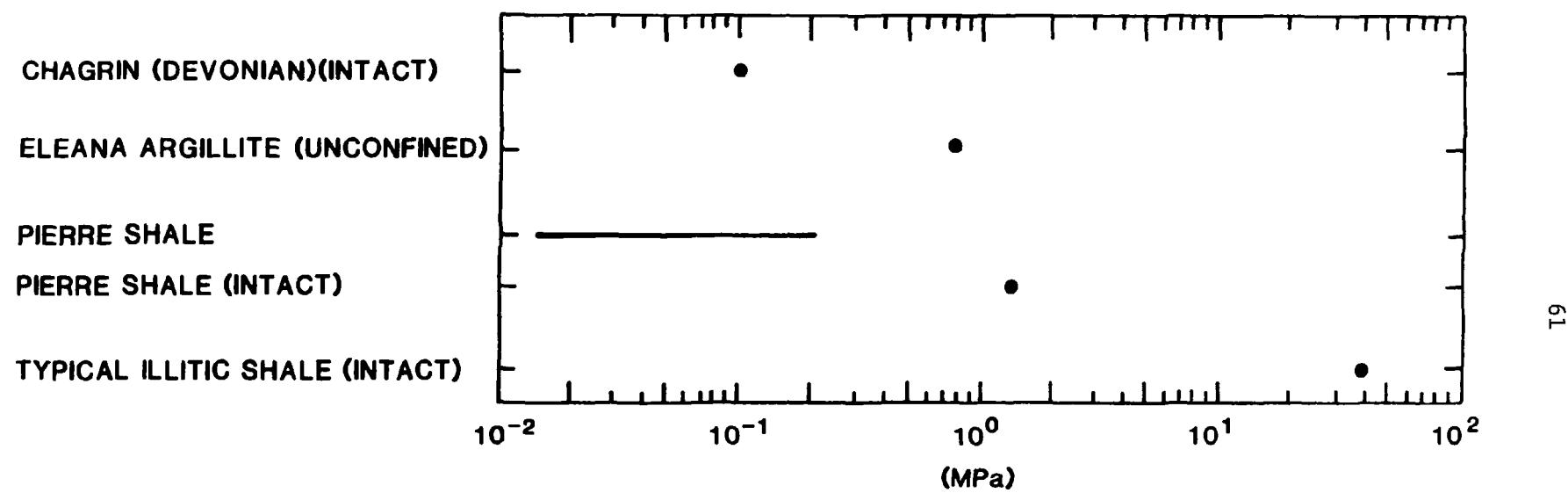


Fig. 36. Cohesion values for selected samples.

CHAGRIN SHALE (INTACT)(DEVONIAN)
CHAGRIN SHALE (UNIAXIAL)(INTACT)
(DEVONIAN)

ELEANA ARGILLITE (UNCONFINED)

OIL SHALES (LOW GRADE)(138 TO 172)
OIL SHALES (HIGH GRADE)(TO 138)

PIERRE SHALE
PIERRE SHALE (UNIAXIAL)(INTACT)

TYPICAL ILLITIC SHALE (UNIAXIAL)(INTACT)

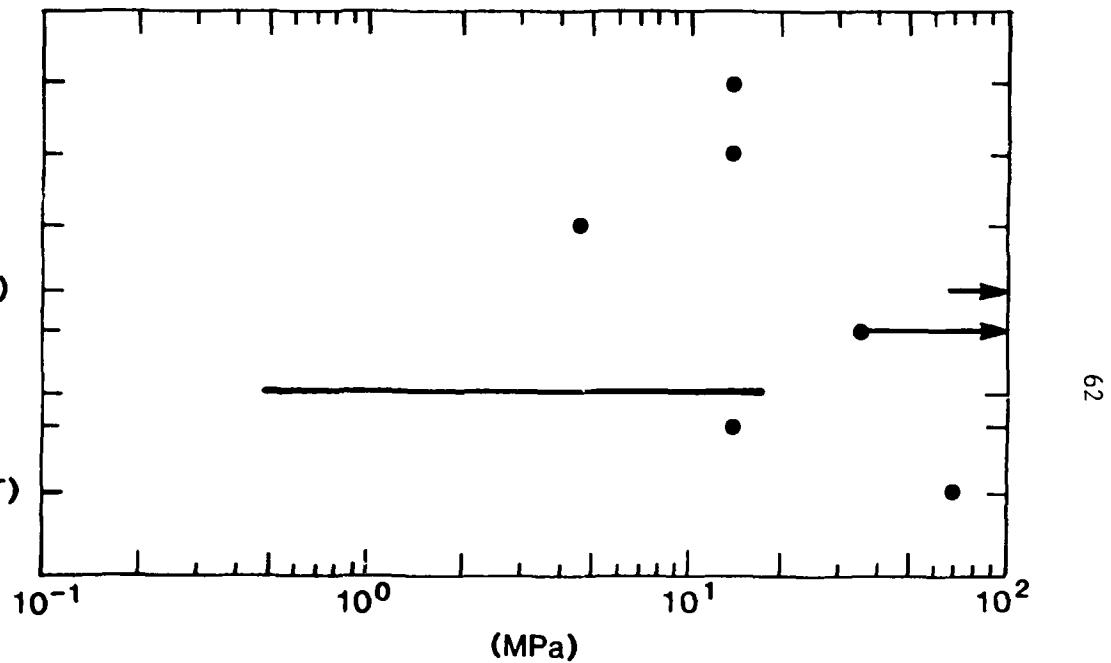


Fig. 37. Compressive strengths for selected samples.

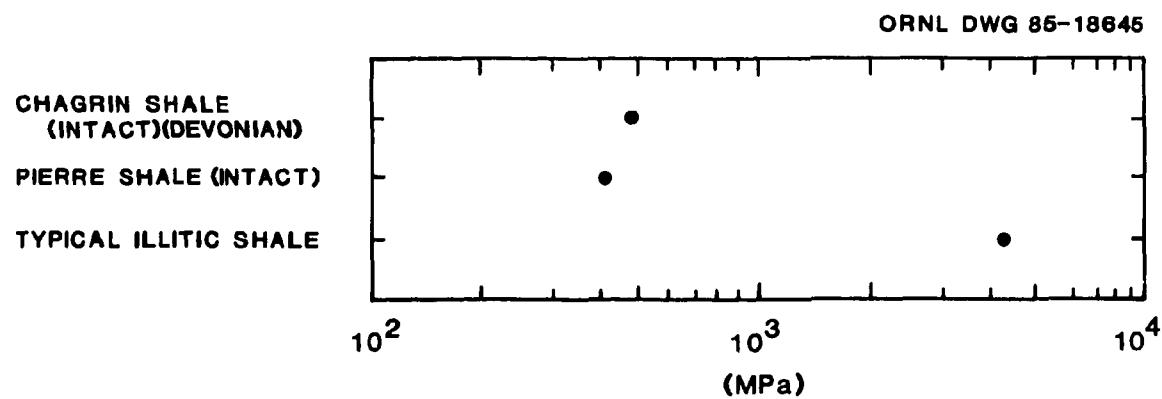


Fig. 38. Shear modulus values for selected samples.

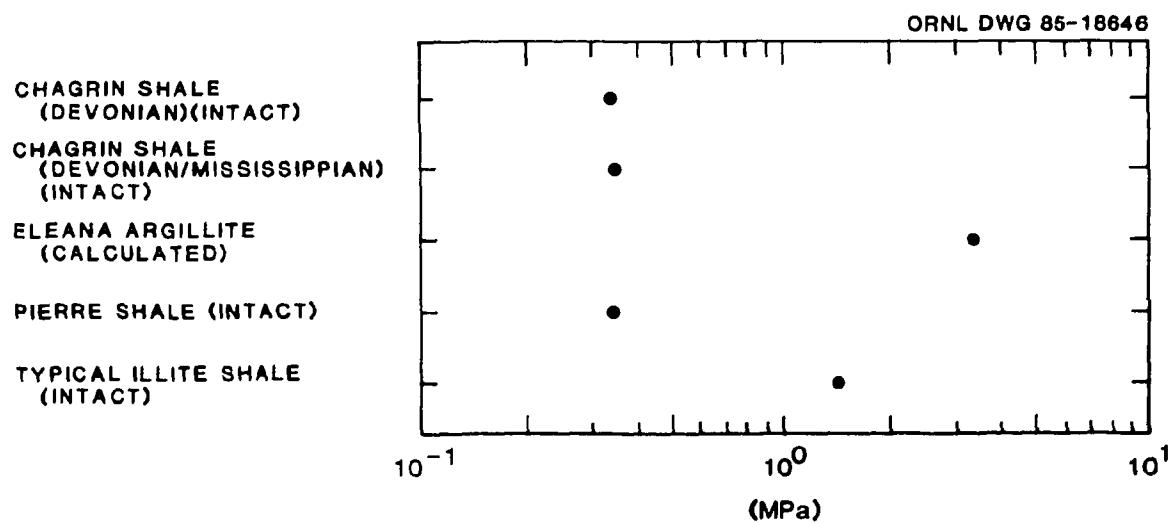


Fig. 39. Tensile strengths for selected samples.

ORNL DWG 85-18647

CHAGRIN SHALE (INTACT) (DEVONIAN)
ELEANNA ARGILLITE (UNCONFINED)
ELEANNA ARGILLITE (RANGES
WITH CONFINING PRESSURE)
OIL SHALES (LOW GRADE) ($> 2.1 \times 10^4$)
OIL SHALES (HIGH GRADE)
PIERRE SHALE
PIERRE SHALE (INTACT)
TYPICAL ILLITIC SHALE

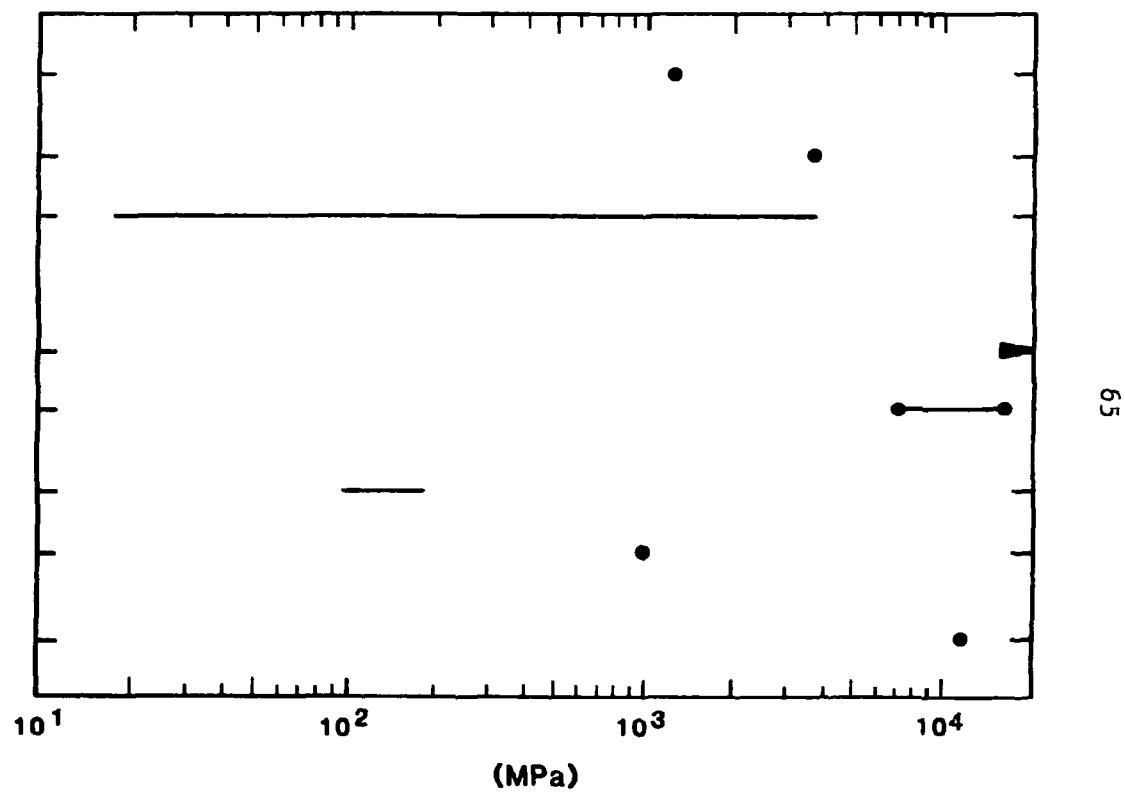


Fig. 40. Young's (elastic) modulus values for selected samples.

ORNL DWG 85-18648

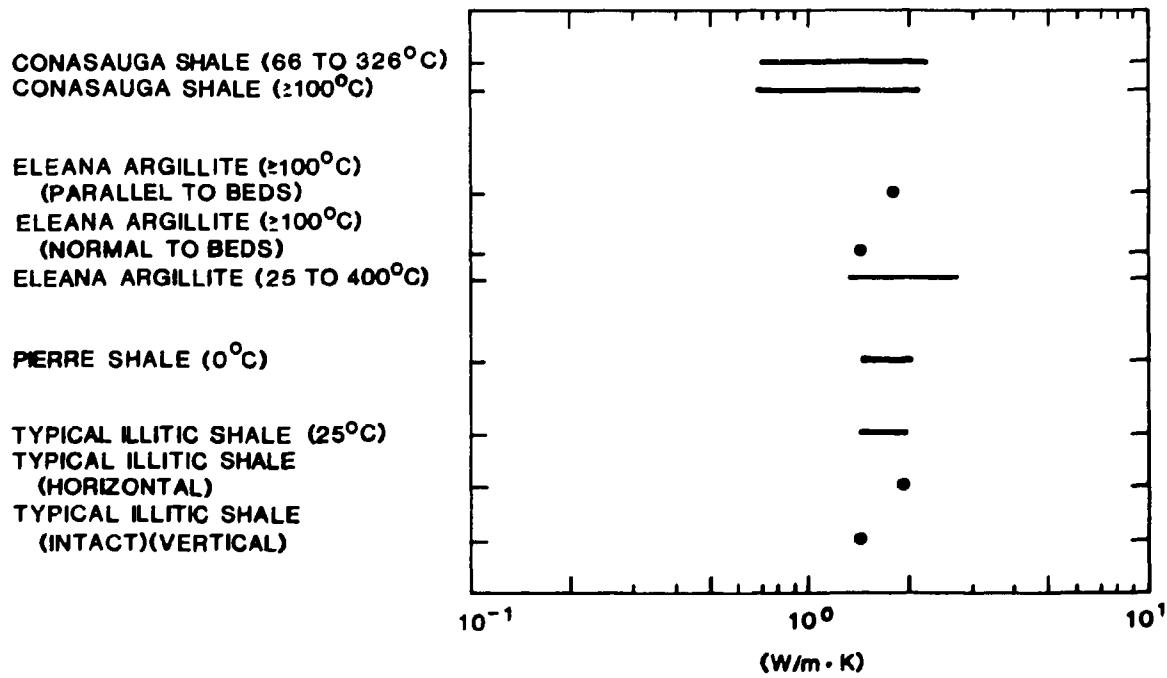


Fig. 41. Thermal conductivities for selected samples.

and (2) uncertainty remains as to whether test results obtained by different investigators (often under different experimental conditions) can be directly compared.

The Conasauga, Devonian, and Pierre Shales appear to have distinctly different ranges of hydraulic conductivities (Fig. 34). The data indicate that the Conasauga has a hydraulic conductivity an order of magnitude lower than that of the Pierre, and the Pierre's conductivity is an order of magnitude lower than that of the Devonian shales. One might have anticipated that Devonian shales would have values intermediate between the Conasauga and the Pierre; however, two rock features might produce the observed order. First, the Devonian shales were probably never buried as deeply as the Conasauga Shale; hence, they would be less compact (or dense), resulting in higher values of porosity and permeability. Second, the Pierre (although much younger and possibly buried less deeply than the Devonian shales) is composed of mixed-layer smectite-illite, smectites, etc., which tend to adsorb water and swell, reducing the rate at which water can pass through the rocks.

Only limited data were available for bulk modulus, cohesion, and shear modulus (Figs. 35, 36, and 38). In general, the Eleana Argillite (of Devonian-Mississippian age) which was subjected to some metamorphism and more illitic shales have higher values for these properties (within two orders of magnitude), suggesting that strength not only increases as a result of compaction but also through recrystallization, grain growth, etc. Note that considerably different values may be obtained when "intact" specimens are tested (e.g., see the values of cohesion for the Pierre in Fig. 36). Unfortunately, the test conditions are not always stated. The values of tensile strength (Fig. 39) are also greater for the Eleana Argillite and "typical illitic shale" than for the Pierre and Devonian shales, presumably for the same reasons.

Several sets of data were available for compressive strength (Fig. 37), but the experimental conditions were quite varied. Some specimens were tested under confined conditions, while others were unconfined (or the experimental conditions were not specified). The Eleana (unconfined) appears weaker than the Pierre and some Devonian shales under confined conditions. Even so, the value for "typical illitic shale" is

nearly an order of magnitude greater than that for the Pierre or the Devonian shales. The compressive strength values for the Pierre range over nearly two orders of magnitude. Based on the mineralogical character of the Pierre, this wide range may be due to factors such as the degree to which specimens have been allowed to air-dry prior to testing. The values reported for "oil shales" (Fig. 37) suggest that they are stronger than (typically organic-rich) Devonian shales. Oil shales with less organic matter (kerogen) appear to be slightly stronger than those that contain more organic matter.

Young's (elastic) modulus values were available for a relatively large number of identified formations (Fig. 40). The values for the Eleana Argillite cover three orders of magnitude (this was said to be related to differences in the confining pressure). The highest values are associated with illite-rich rocks and those rich in organic (kerogen) matter.

The range of values for thermal conductivity (Fig. 41) appears to be very narrow (less than an order of magnitude) and generally unrelated to clay mineralogy and/or age. The Conasauga Shales, which are older, have the lowest values recorded here; however, the experimental conditions vary widely with respect to ambient temperature, test direction, etc., making comparisons difficult. Other studies suggest that the presence of larger grains of quartz or other rocks, density, and the presence of pore fluids may influence the thermal properties of shales to a greater extent than the composition of the individual clay minerals present.

10. SUMMARY AND RECOMMENDATIONS

The primary goal of this study was to determine the viability of making preliminary selections of shales and other clay-rich materials for the disposal of radioactive wastes on the basis of their clay mineral composition, as reported in the literature. The results of this study show that some properties of these rocks can be predicted on the basis of the amounts and types of clay minerals present. Examples were given to illustrate the role that clay minerals play in determining certain chemical, hydrologic, and mechanical properties. Overall, thermal properties appeared to be least affected by clay mineral composition. It should be

even easier to select materials for use in buffers and backfills, based on the properties that have been determined for specific clays and other minerals.

Several difficulties were encountered during the course of this study. One of the major difficulties was the lack of uniformity in, and lack of information about, the test methods used. The results of tests made on several different materials cannot be compared with confidence when the experimental conditions (e.g., temperature, nature of fluids present, confining stresses) are not identical or nearly so. Also, the lack of uniformity of units used to report the results mandated the use of conversion factors and introduced the possibility of errors. There were comparatively few cases for which the mineral composition of the material being tested was stated. Even when compositions were stated, they were rarely quantified; and they were probably determined on other samples, which may not have been taken at the same locality as the test specimens.

It is suggested that two things be done:

1. The present study should be extended for selected formations (e.g., the Conasauga Shale, Pierre Shale) by using the original references, rather than reports that may exclude important background information, to fill in gaps that may exist in the data (e.g., specific sample locations, depths, and formation names, which are often omitted when data are summarized).
2. Emphasis should be placed on uniformity in laboratory methods, experimental conditions, report formats, and reporting units for all samples to be tested in the future. Reports should include mineralogical analyses of sample splits, as well as petrologic and SEM studies to determine the extent of cementation and grain orientations. When the results of chemical, hydrologic, mechanical, and thermal tests are compared with respect to the mineralogical and petrologic character of the samples, we should be better able to select specific shale formations or other clay-rich rocks if it should become desirable to use shales as potential host rocks for radioactive waste disposal. The necessity for in situ testing of properties such as hydraulic conductivity cannot be overemphasized.

Some of the information reported here refers to specific clay minerals or mixtures which might be used for buffers and/or backfill. Such material can be characterized more readily than natural shales and argillites. Although additional work will be needed, the available information suggests that it will be possible to produce buffers and backfills that have the chemical, hydrologic, mechanical, and thermal properties necessary to safely contain specific kinds of radioactive wastes. Although the host formation will remain the ultimate barrier, tailored buffers and backfills can reduce the likelihood that waste products will reach the host formation for very long times.

11. CONVERSION FACTORS USED

<u>To convert from:</u>	<u>To:</u>	<u>Multiply by:</u>
Btu/lb • °F	J/kg • K	4.185 × 10 ³
Btu/h • ft • °F	W/m • K	1.730 × 10 ⁰
cal/cm • s • °C	W/m • K	4.184 × 10 ²
cm ² /h	m ² /s	2.780 × 10 ⁻⁸
cm ² /s	m ² /s	1.000 × 10 ⁻⁴
°F	°C	5.560 × 10 ⁻¹
ft/s	cm/s	3.048 × 10 ¹
ft/year	cm/s	9.664 × 10 ⁻⁷
ft ² /h	m ² /s	2.580 × 10 ⁻⁵
J/s • m • °C	W/m • K	1.000 × 10 ⁰
kg/cm ²	Pa	9.810 × 10 ⁴
kg/m ³	g/cm ³	1.000 × 10 ⁻³
lb/ft ³	g/cm ³	16.018 × 10 ⁻³
md	cm/s	9.600 × 10 ⁻⁷
metric ton (tonne)	kg	1.000 × 10 ³
metric ton (tonne)	g	1.000 × 10 ⁶
Mg/m ³	g/cm ³	1.000 × 10 ⁰
m/s	cm/s	1.000 × 10 ²
m ²	cm/s	9.700 × 10 ⁸
psi	Pa	6.890 × 10 ³
W/cm • °C	W/m • K	1.000 × 10 ²

Note: k = kilo = × 10³; M = mega = × 10⁶; G = giga = × 10⁹.

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13. APPENDIXES

Summaries of the information contained in reports cited earlier are presented in Appendixes A, B, C, and D, which follow. Appendix A, which is the most complete of these, is divided into five sections: chemical properties (Database A.1), general physical properties (Database A.2), hydrologic properties (Database A.3), mechanical properties (Database A.4), and thermal properties (Database A.5).

The categories in the Databases are alphabetized; the last four categories to be alphabetized were: location, formation, material, and property class. For most purposes, the last two categories are the most important [e.g., all the information found for the property class "hydraulic conductivity (minerals)" is listed under its "material" name in alphabetical order]. Note that lower-case letters, for example, (a), (b), (c), which follow some material names, were added to facilitate the location of a set of data shown in a specific figure in the body of this report. These letters do not cross-reference materials from one category to any other category.

Insofar as possible, an attempt was made to retain the original terminology and units presented in the report from which the information was derived. If the terminology and/or units used were acceptable, only that information is given; however, in many cases the terms and/or units reported either were not uniform or are not currently accepted. Where possible, the proper terms were added and the units were corrected by multiplying by an appropriate conversion factor (see Sect. 11) so that the values can be compared directly in Figs. 1-41. For example, the term "permeability" may be followed by the term "(hydraulic conductivity)" if that is appropriate for the property reported. Similarly, if the report gave a value for pressure in English units, such as psi, this value is followed by its SI equivalent, MPa.

In addition, three abbreviated Appendixes (B, C, and D) are provided to assist the user in locating specific information. These appendixes use the same five major divisions as presented earlier for Appendix A. Appendix B was alphabetized on the basis of the property cited. Appendix C was arranged so that the material names are listed alphabetically.

Appendix D was alphabetized on the basis of formation name where that information was supplied in the report. Appendix D is the shortest appendix because formation names are often omitted. This information may be available in the original references.

If an interesting item is located in Appendix B, C, or D, the user can either access Appendix A (to review the more complete summary for that entry) or go directly to the source. Potential users are encouraged to take time to become familiar with the formats used.

Finally, the computer program employed here did not permit the use of subscripts or superscripts. Many of the experimental values are given to powers of 10. These values are shown parenthetically on the line, following the numeral 10; for example, $10(6) = 10^6$ and $10(-12) = 10^{-12}$. Nor did the program permit the use of a centered period; hence, units such as $W/m \cdot K$ are shown with a dash (e.g., $W/m-K$) in the Appendixes.

13.1 Appendix A. DATABASES

13.1.1 Appendix A.1. CHEMICAL PROPERTIES

Property class: Diffusivity
Material: Bentonite
 Formation: -
 Location: -
 Condition 1: 10% bentonite + sand
 Condition 2: Sr(+2) ion
 Condition 3: -
Property/units: Diffusivity (m²/s)
 ranges from: 1.3 x 10(-10)
 to: -
 as: -
 ranges from: - to: -
Reference: Neretnieks (1977)
Source: ONWI-312 (1981), p. 14

Property class: Ion exchange
Material: Allophane
 Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -
Property/units: Ion exchange capacity (meq/100 g)
 ranges from: 70
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange
Material: Bentonite
 Formation: -
 Location: -
 Condition 1: pH = 7 and 9
 Condition 2: NaCl = 10(-2) and 10(-3) molar
 Condition 3: Ion used: Cs
Property/units: Ion exchange capacity (meq/100 g)
 ranges from: 0.1
 to: 100
 as: Concentration Cs (mol/dm³)
 ranges from: ca. 10(-6) to: ca. 100
Reference: -
Source: NUREG/CP-0052 (1983), p. 181

Property class: Ion exchange
Material: Bentonite (Na) (a)
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: 2.5% organic content
 Condition 3: -
Property/units: Ion exchange capacity (meq/100 g)
 ranges from: 68.6
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: AECL-7825 (1984), p. 12

Property class: Ion exchange
Material: Bentonite (Na) (b)
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: 50% sand mixture
 Condition 3: -
Property/units: Ion exchange capacity (meq/100 g)
 ranges from: 34.3
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: AECL-7825 (1984), p. 12

Property class: Ion exchange
Material: Chlorite (a)
 Formation: -
 Location: -
 Condition 1: pH 7
 Condition 2: -
 Condition 3: -
Property/units: Ion exchange capacity (meq/100 g)
 ranges from: 10-40
 to: -
 as: -
 ranges from: - to: -
Reference: Grim (1968)
Source: ONWI-486 (1983), p. 67

Property class: Ion exchange
Material: Chlorite (b)
 Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -
Property/units: Ion exchange capacity (meq/100 g)
 ranges from: 10
 to: 40
 as: -
 ranges from: - to: -
Reference: Several refs
Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange
Material: Clay
 Formation: Boom Clay
 Location: Belgium
 Condition 1: Vermiculite 30%, illite 25%, smectite 20%
 Condition 2: -
 Condition 3: -
Property/units: Ion exchange capacity (meq/100 g)
 ranges from: ca. 20
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Proc NEA Workshop OECD (1979a), p. 88

Property class: Ion exchange
 Material: Glauconite

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 11
 to: 20
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange
 Material: Halloysite

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 5
 to: 10
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange

Material: Illite (a)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 10
 to: 40
 as: -

ranges from: - to: -

Reference: Grim (1968)

Source: ONWI-486 (1983), p. 67

Property class: Ion exchange

Material: Illite (b)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 16
 to: 50
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange
 Material: Kaolinite (a)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 3
 to: 15
 as: -

ranges from: - to: -

Reference: Grim (1968)

Source: ONWI-486 (1983), p. 67

Property class: Ion exchange
 Material: Kaolinite (b)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 2
 to: 15
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange

Material: Palygorskite

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 20
 to: 30
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange

Material: Smectite

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 80
 to: 150
 as: -

ranges from: - to: -

Reference: Grim (1968)

Source: ONWI-486 (1983), p. 67

Property class: Ion exchange
 Material: Smectite (Ca)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 80
 to: 150
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange
 Material: Smectite (Ca)

Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity (meq/g)
 (?)

ranges from: 93
 to: 12
 as: Temperature (C)

ranges from: 105 to: 390

Reference: Grim (1968)

Source: ONWI-312 (1981), p. 24

Property class: Ion exchange
 Material: Smectite (Li)

Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity (meq/g)
 (?)

ranges from: 56
 to: 20
 as: Temperature (C)

ranges from: 105 to: 200

Reference: Grim (1968)

Source: ONWI-312 (1981), p. 24

Property class: Ion exchange
 Material: Smectite (Na)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 100
 to: 150
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Ion exchange
 Material: Smectite (Na)

Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity (meq/g)
 (?)

ranges from: 95
 to: 68
 as: Temperature (C)

ranges from: 105 to: 390

Reference: Grim (1968)

Source: ONWI-312 (1981), p. 24

Property class: Ion exchange
 Material: Vermiculite (a)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 100
 to: 150
 as: -

ranges from: - to: -

Reference: Grim (1968)

Source: ONWI-486 (1983), p. 67

Property class: Ion exchange
 Material: Vermiculite (b)

Formation: -
 Location: -
 Condition 1: pH = 7
 Condition 2: -
 Condition 3: -

Property/units: Ion exchange capacity
 (meq/100 g)

ranges from: 100
 to: 150+
 as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (in preparation) p. 152

Property class: Sorption
 Material: Argillite

Formation: Eleana Argillite
 Location: -
 Condition 1: Ions used: Am, Ba, Ce, Cm,
 Cs, Eu, Pm, Ra, Sr, Tc, U
 Condition 2: Sources of variability:
 method, source, fluid comp,
 R-N conc, temp
 Condition 3: -

Property/units: Sorption coefficient (Kd)
 (ml/g)

ranges from: 0
 to: 1 x 10(5)
 as: -

ranges from: - to: -

Reference: Three refs

Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Attapulgite
 Formation: -
 Location: -
 Condition 1: Ions used: Am, Cm, I, Rb, Sr
 Condition 2: Sources of variability: Na conc, time, pH, fluid comp
 Condition 3: -
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: $1 \times 10(-2)$ to: $2 \times 10(4)$ as: -
 ranges from: - to: -
 Reference: Baillargeon et al (1979)
 Source: ONWI-312 (1981), p. 35

Property class: Sorption
 Material: Bentonite (Ca)
 Formation: -
 Location: -
 Condition 1: Grande Ronde ground water
 Condition 2: Sr Ions
 Condition 3: pH 9.85 (initial), pH 8.6 (final)
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: $1.2 \times 10(3)$ to: 865 as: Time (days)
 ranges from: 14 to: 28
 Reference: -
 Source: ONWI-312 (1981), p. 35

Property class: Sorption
 Material: Bentonite (Na)
 Formation: -
 Location: -
 Condition 1: Grand Ronde ground water
 Condition 2: pH 9.85 (initial), pH 8.6 (final)
 Condition 3: Sr Ions
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: $5.0 \times 10(3)$ to: $6.8 \times 10(3)$ as: Time (days)
 ranges from: 14 to: 28
 Reference: -
 Source: ONWI-312 (1981), p. 35

Property class: Sorption
 Material: Bentonite (Na)
 Formation: -
 Location: -
 Condition 1: Grande Ronde ground water
 Condition 2: I Ions
 Condition 3: -
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: 0.4 to: 8.6 as: Time (days)
 ranges from: 14 to: 28
 Reference: -
 Source: ONWI-312 (1981), p. 35

Property class: Sorption
 Material: Bentonite (Na)
 Formation: -
 Location: -
 Condition 1: Grande Ronde ground water
 Condition 2: Cs Ions
 Condition 3: -
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: $1.1 \times 10(3)$ to: $1.0 \times 10(3)$ as: Time (days)
 ranges from: 14 to: 28
 Reference: -
 Source: ONWI-312 (1981), p. 35

Property class: Sorption
 Material: Bentonite (Ca)
 Formation: -
 Location: -
 Condition 1: Grande Ronde ground water
 Condition 2: Cs Ions
 Condition 3: pH 9.85 (initial), pH 8.6 (final)
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: 2.5 to: 3.2 as: Time (days)
 ranges from: 14 to: 28
 Reference: -
 Source: ONWI-312 (1981), p. 35

Property class: Sorption

Material: Bentonite (Na)

Formation: -

Location: -

Condition 1: Ions used: Am, Cs, Eu, Ra, Sr, Tc

Condition 2: Sources of variability: pH, temp, fluid comp

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 0

to: $4 \times 10(4)$

as: -

ranges from: - to: -

Reference: Nowak (1980)

Source: ONWI-486 (1983), p. 73

Property class: Sorption

Material: Bentonite (Na) (Accofloc-350)

Formation: -

Location: -

Condition 1: Grande Ronde ground water

Condition 2: pH 9.85 (initial), pH 8.6 (final)

Condition 3: Cs Ions

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: $1.3 \times 10(3)$ to: $1.1 \times 10(3)$

as: Time (days)

ranges from: 14 to: 28

Reference: -

Source: ONWI-312 (1981), p. 35

Property class: Sorption

Material: Bentonite (Na) (Accofloc-350)

Formation: -

Location: -

Condition 1: Grande Ronde ground water

Condition 2: pH 9.85 (initial), pH 8.6 (final)

Condition 3: I Ions

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 1.2

to: 0.1

as: Time (days)

ranges from: 14 to: 28

Reference: -

Source: ONWI-312 (1981), p. 35

Property class: Sorption

Material: Bentonite (Na) (Accofloc-350)

Formation: -

Location: -

Condition 1: Grande Ronde ground water

Condition 2: pH 9.85 (initial), pH 8.6 (final)

Condition 3: Sr Ions

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: $1.5 \times 10(3)$ to: $1.5 \times 10(3)$

as: Time (days)

ranges from: 14 to: 28

Reference: -

Source: ONWI-312 (1981), p. 35

Property class: Sorption

Material: Bentonite (Na) (Saline Seal-100)

Formation: -

Location: -

Condition 1: Grande Ronde ground water

Condition 2: pH 9.85 (initial), pH 8.6 (final)

Condition 3: Cs Ions

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: $2.6 \times 10(3)$ to: $3.8 \times 10(3)$

as: Time (days)

ranges from: 14 to: 28

Reference: -

Source: ONWI-312 (1981), p. 35

Property class: Sorption

Material: Bentonite (Na) (Saline Seal-100)

Formation: -

Location: -

Condition 1: Grande Ronde ground water

Condition 2: pH 9.85 (initial), pH 8.6 (final)

Condition 3: I Ions

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 2.8

to: 3.6

as: Time (days)

ranges from: 14 to: 28

Reference: -

Source: ONWI-312 (1981), p. 35

Property class: Sorption

Material: Bentonite (Na) (Saline Seal-100)

Formation: -

Location: -

Condition 1: Grande Ronde ground water

Condition 2: pH 9.85 (initial), pH 8.6 (final)

Condition 3: Sr Ions

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: $1.2 \times 10(3)$ to: $1.5 \times 10(3)$

as: Time (days)

ranges from: 14 to: 28

Reference: -

Source: ONWI-312 (1981), p. 35

Property class: Sorption

Material: Bentonite and Quartz

Formation: -

Location: -

Condition 1: Ions used: Am, Ce, Cs, Eu, I, Np, Pu, Ra, Sr, Tc, U

Condition 2: Sources of variability: fluid comp, temp, R-N conc

Condition 3: 1:9 mixture

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: <1

to: $1 \times 10(4)$

as: -

ranges from: - to: -

Reference: Allard et al (1979)

Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Bentonite and Sand
 Formation: -
 Location: -
 Condition 1: Ions used: Am, Ra
 Condition 2: Sources of variability: fluid comp, pH
 Condition 3: 1:9 mixture
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: 490 to: $9.5 \times 10(3)$ as: -
 ranges from: - to: -
 Reference: Nowak (1980)
 Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Clay
 Formation: Boom Clay
 Location: Belgium
 Condition 1: Anion used = I
 Condition 2: Various concentrations and depths
 Condition 3: pH = 3
 Property/units: Sorption coefficient (Kd) (ml/g?)
 ranges from: 0.87 to: 6.12 as: -
 ranges from: - to: -
 Reference: -
 Source: Proc NEA Workshop OECD (1979a), p. 97

Property class: Sorption
 Material: Clay (Na)
 Formation: -
 Location: Belle Fourche
 Condition 1: Ion used: Cs
 Condition 2: Sources of variability: pH, fluid comp
 Condition 3: -
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: 5.6 to: $5.7 \times 10(3)$ as: -
 ranges from: - to: -
 Reference: Silva et al (1979)
 Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Hectorite
 Formation: -
 Location: -
 Condition 1: Ions used: Cs, Eu, Sr, Tc
 Condition 2: Sources of variability: fluid comp, pH, temp
 Condition 3: -
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: 0.4 to: $7.2 \times 10(3)$ as: -
 ranges from: - to: -
 Reference: Nowak (1980)
 Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Hectorite and Sand
 Formation: -
 Location: -
 Condition 1: Ion used: Ra
 Condition 2: Sources of variability: fluid comp, pH
 Condition 3: 1:9 mixture
 Property/units: Sorption coefficient (Kd) (ml/g)
 ranges from: 400 to: 1300 as: -
 ranges from: - to: -
 Reference: Nowak (1980)
 Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Illite
 Formation: -
 Location: -
 Condition 1: Ion used: Cs
 Condition 2: 0.2 mol/L NaCl
 Condition 3: -
 Property/units: Sorption coefficient (Kd) (m(3)/kg) (?)
 ranges from: 0.9 to: - as: -
 ranges from: - to: -
 Reference: -
 Source: AECL-7812 (1983), p. 25

Property class: Sorption
 Material: Illite
 Formation: -
 Location: -
 Condition 1: Ions used: Sr
 Condition 2: 0.04 to 0.2 mol/L NaCl (and NaOAc)
 Condition 3: pH = 5
 Property/units: Sorption coefficient (Kd) (m(3)/kg) (?)
 ranges from: 0.005 to: 0.02 as: -
 ranges from: - to: -
 Reference: Three refs
 Source: AECL-7812 (1983), p. 25

Property class: Sorption
 Material: Illite
 Formation: -
 Location: -
 Condition 1: Ions used: U, Co
 Condition 2: 0.04 mol/L NaCl
 Condition 3: pH = 5
 Property/units: Sorption coefficient (Kd) (m(3)/kg) (?)
 ranges from: 0.045 to: 0.090 as: -
 ranges from: - to: -
 Reference: -
 Source: AECL-7825 (1984), p. 25

Property class: Sorption

Material: Illite

Formation: -

Location: -

Condition 1: Ions used: Co, Sr, Nb, Ru, Cs, Th, U, Np, Pu, Am

Condition 2: Sources of variability: pH, temp

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 0 to: $3 \times 10(5)$ as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (In preparation)
p. 132-133

Property class: Sorption

Material: Illite

Formation: -

Location: -

Condition 1: pH = 7.5

Condition 2: Ions used: I, Tc, Np, Sr, Cs, Am, Sm, Sr

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g?)

ranges from: 1 to: $3 \times 10(6)$ as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1979a), p. 304

Property class: Sorption

Material: Kaolinite

Formation: -

Location: -

Condition 1: Ion used: Sr

Condition 2: 0.04 to 0.2 mol/L NaCl (and NaOAc)

Condition 3: pH = 5

Property/units: Sorption coefficient (Kd) (ml(3)/kg) (?)

ranges from: 0.003 to: 0.006 as: -

ranges from: - to: -

Reference: Three refs

Source: AECL-7812 (1983), p. 25

Property class: Sorption

Material: Kaolinite

Formation: -

Location: -

Condition 1: Ions used: Am, Cm, Sm, U, Co

Condition 2: 0.04 to 0.25 mol/L NaCl

Condition 3: pH = 5

Property/units: Sorption coefficient (Kd) (ml(3)/kg) (?)

ranges from: 0.002 to: 0.04 as: -

ranges from: - to: -

Reference: Two refs

Source: AECL-7812 (1983), p. 25

Property class: Sorption

Material: Kaolinite

Formation: -

Location: -

Condition 1: Ions used: Cs

Condition 2: 0.2 to 0.5 mol/L NaCl; 0.01 mol/L NaOAc

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml(3)/kg) (?)

ranges from: 0.02 to: -

as: -

ranges from: - to: -

Reference: -

Source: AECL-7812 (1983), p. 25

Property class: Sorption

Material: Kaolinite

Formation: -

Location: -

Condition 1: Ions used: Am, Cf, Cm, Es, Eu, La, Sm, Tc, Yb

Condition 2: Sources of variability: pH, fluid comp, Na conc, R-N conc

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 0.1 to: $1.6 \times 10(3)$ as: -

ranges from: - to: -

Reference: Three refs

Source: ONWI-486 (1983), p. 73

Property class: Sorption

Material: Kaolinite

Formation: -

Location: -

Condition 1: Ions used: Co, Sr, Nb, Tc, Ru, Cs, Sm, Eu, Th, U, Np, Pu, Am

Condition 2: Sources of variability: pH, temp

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 0 to: $3 \times 10(5)$ as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2/(in preparation)

p. 132-133

Property class: Sorption

Material: Kaolinite

Formation: -

Location: -

Condition 1: pH = 6.5

Condition 2: Ions used: I, Np, Tc, Sr, Cs, Zr, Pu, Am, Sm

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g?)

ranges from: 1 to: $2 \times 10(4)$ as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1979a),

p. 304

Property class: Sorption
 Material: Kaolinite (a)
 Formation: -
 Location: Georgia
 Condition 1: American Clay Institute
 Source Clay KGa-1
 Condition 2: Tested in basalt ground
 water; Ions: Sr, Cs, Am
 Condition 3: Tested for 28 days at 25
 deg C
 Property/units: Batch distribution ratio (Rd)
 (ml/g?)
 ranges from: $1.28 \times 10(2)$
 to: $9.22 \times 10(2)$
 as: -
 ranges from: - to: -

Reference: -
 Source: PNL-4452 UC-70 (1983), p. 18

Property class: Sorption
 Material: Kaolinite (b)
 Formation: -
 Location: Georgia
 Condition 1: American Clay Institute
 Source Clay KGa-2
 Condition 2: Tested in basalt ground
 water; Ions used: Sr, Cs, Am
 Condition 3: Tested for 28 days at 25
 deg C
 Property/units: Batch distribution ratio (Rd)
 (ml/g?)
 ranges from: $1.88 \times 10(2)$
 to: $9.0 \times 10(3)$
 as: -
 ranges from: - to: -

Reference: -
 Source: PNL-4452 UC-70 (1983), p. 18

Property class: Sorption
 Material: Kaolinite (Ca)
 Formation: -
 Location: -
 Condition 1: Ion used: Cs
 Condition 2: -
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (Log) (ml/g?)
 ranges from: ca. 2.3
 to: ca. 1.5
 as: Log C calcium chloride
 ranges from: (-3) to: ca. 0.5
 Reference: -
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Property class: Sorption
 Material: Kaolinite (Ca)
 Formation: -
 Location: -
 Condition 1: Ion used: Sr
 Condition 2: -
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (Log) (ml/g?)
 ranges from: ca. 1.3
 to: ca. (-1)
 as: Log C calcium chloride
 ranges from: (-3) to: ca. 0
 Reference: -
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Property class: Sorption
 Material: Kaolinite (Na)
 Formation: -
 Location: -
 Condition 1: Ion used: Cs
 Condition 2: -
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (Log) (ml/g?)
 ranges from: ca. 2.3
 to: ca. 1.3
 as: Log C NaCl
 ranges from: (-2) to: ca. 1
 Reference: -
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Property class: Sorption
 Material: Kaolinite (Na)
 Formation: -
 Location: -
 Condition 1: Ion used: Sr
 Condition 2: -
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (Log) (ml/g?)
 ranges from: >2
 to: <0
 as: Log C NaCl
 ranges from: (-2) to: ca. 0.5
 Reference: -
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Property class: Sorption
 Material: Nontronite
 Formation: -
 Location: -
 Condition 1: Ions used: Am, Cs, I, Np, Pu,
 Ra, Se, Sr, Tc, U
 Condition 2: Sources of variability: pH,
 R-N conc, Eh, temp, sol:sorb
 ratio
 Condition 3: Mineralization in basalt
 fractures and vugs
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 0
 to: $2.25 \times 10(5)$
 as: -
 ranges from: - to: -

Reference: Two refs

Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Shale
 Formation: Conasauga Shale
 Location: -
 Condition 1: Ions used: Cs, Rb, Sr
 Condition 2: Sources of variability: not
 stated
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 57
 to: 100
 as: -
 ranges from: - to: -

Reference: Komarneni and Roy (1980)
 Source: ONWI-486 (1983), p. 73

Property class: Sorption

Material: Shale

Formation: Dewey Lake Redbeds

Location: -

Condition 1: Ion used: Eu

Condition 2: Sources of variability: pH,
temp, fluid comp

Condition 3: -

Property/units: Sorption coefficient (Kd)
(ml/g)

ranges from: 200

to: $1.4 \times 10(4)$

as: -

ranges from: - to: -

Reference: Nowak (1980)

Source: ONWI-486 (1983), p. 73

Property class: Sorption

Material: Smectite

Formation: -

Location: -

Condition 1: Calculated values

Condition 2: NaCl conc = $10(-2)$ molar

Condition 3: 25 deg C

Property/units: Sorption coefficient (Kd)
(cm³/g) (ml/g)

ranges from: ca. 188

to: ca. 200

as: Weight % clay

ranges from: ca. 5 to: ca. 95

Reference: -

Source: NUREG/CP-0052 (1983), p. 186

Property class: Sorption

Material: Smectite

Formation: -

Location: -

Condition 1: Ion used: Cs

Condition 2: 0.2 to 0.5 mol/L NaCl; 0.01
mol/L NaOAC

Condition 3: pH = 5

Property/units: Sorption coefficient (Kd)
(m³/kg) (?)

ranges from: 0.06

to: 0.7

as: -

ranges from: - to: -

Reference: -

Source: AECL-7812 (1983), p. 25

Property class: Sorption

Material: Smectite

Formation: -

Location: -

Condition 1: Ions used: Eu, Am, Cm, Sm, U,
CoCondition 2: 0.04 to 0.25 mol/L NaCl (and
NaOAC)

Condition 3: pH = 5

Property/units: Sorption coefficient (Kd)
(m³/kg) (?)

ranges from: 0.034

to: 0.65

as: -

ranges from: - to: -

Reference: Three refs

Source: AECL-7812 (1983), p. 25

Property class: Sorption

Material: Smectite

Formation: -

Location: -

Condition 1: Ions used: Sr

Condition 2: 0.04 to 0.2 mol/L NaCl (and
NaOAC)

Condition 3: pH = 5

Property/units: Sorption coefficient (Kd)
(m³/kg) (?)

ranges from: 0.030

to: 0.6

as: -

ranges from: - to: -

Reference: Three refs

Source: AECL-7812 (1983), p. 25

Property class: Sorption

Material: Smectite

Formation: -

Location: -

Condition 1: Ions used: Co, Sr, Nb, Tc,
Ru, I, Cs, Sm, Eu, U, Np, Pu,
AmCondition 2: Sources of variability: pH,
temp

Condition 3: -

Property/units: Sorption coefficient (Kd)
(ml/g)

ranges from: 0

to: $4 \times 10(5)$

as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-6241/V2 (In preparation)
p. 132-133

Property class: Sorption

Material: Smectite

Formation: -

Location: -

Condition 1: Various pH's, salinities,
flow rates, etc.

Condition 2: Several ion species

Condition 3: -

Property/units: Sorption coefficient (ml/g)

ranges from: 200

to: 2,000

as: -

ranges from: - to: -

Reference: Nowak (1979)

Source: ONWI-312 (1981), p. 13

Property class: Sorption

Material: Smectite

Formation: -

Location: Arizona

Condition 1: American Clay Institute

Source Clay SAz-1

Condition 2: Tested in basalt ground
water; Ions used: Sr, Cs, Am

Condition 3: Tested for 28 days at 25

deg C

Property/units: Batch distribution ratio (Rd)

(ml/g?)

ranges from: $8.15 \times 10(2)$ to: $2.7 \times 10(3)$

as: -

ranges from: - to: -

Reference: -

Source: PNL-4452 UC-70 (1983), p. 18

Property class: Sorption
 Material: Smectite
 Formation: -
 Location: Arizona
 Condition 1: Ions used: Cs, Rb, Sr
 Condition 2: Sources of variability: not stated
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 260
 to: 750
 as: -
 ranges from: - to: -
 Reference: Komarneni and Roy (1980)
 Source: ONWI-486 (1983), p. 73

Property class: Sorption
 Material: Smectite
 Formation: -
 Location: Texas
 Condition 1: American Clay Institute
 Source Clay STx-1
 Condition 2: Tested in basalt ground
 water; Ions used: Sr, Cs, Am
 Condition 3: Tested for 28 days at 25
 deg C
 Property/units: Batch distribution ratio (Rd)
 (ml/g?)
 ranges from: $1.4 \times 10(3)$
 to: $1.9 \times 10(3)$
 as: -
 ranges from: - to: -
 Reference: -
 Source: PNL-4452 UC-70 (1983), p. 18

Property class: Sorption
 Material: Smectite
 Formation: -
 Location: Texas
 Condition 1: Saturated NaCl brine
 Condition 2: Ion used: Cs
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 310
 to: 685
 as: Hydrothermal alteration
 ranges from: Untreated to: 200 deg C,
 30 MPa
 Reference: Roy and Burns
 Source: Sci Basis for Waste Management - V
 (1982), p. 638

Property class: Sorption
 Material: Smectite
 Formation: -
 Location: Texas
 Condition 1: Saturated NaCl brine
 Condition 2: Ion used: Cs
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 410
 to: 400
 as: Hydrothermal alteration
 ranges from: Untreated to: 200 deg C,
 30 MPa
 Reference: Roy and Burns
 Source: Sci Basis for Waste Management - V
 (1982), p. 638

Property class: Sorption
 Material: Smectite
 Formation: -
 Location: Texas
 Condition 1: Saturated NaCl brine
 Condition 2: Ion used: Sr
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 310
 to: 370
 as: Hydrothermal alteration
 ranges from: Untreated to: 200 deg C,
 30 MPa
 Reference: Roy and Burns
 Source: Sci Basis for Waste Management - V
 (1982), p. 638

Property class: Sorption
 Material: Smectite
 Formation: -
 Location: Wyoming
 Condition 1: American Clay Institute
 Source Clay SWy-1
 Condition 2: Tested in basalt ground
 water; Ions used: Sr, Cs, Am
 Condition 3: Tested for 28 days at 25
 deg C
 Property/units: Batch distribution ratio (Rd)
 (ml/g?)
 ranges from: $1.0 \times 10(3)$
 to: $2.0 \times 10(3)$
 as: -
 ranges from: - to: -
 Reference: -
 Source: PNL-4452 UC-70 (1983), p. 18

Property class: Sorption
 Material: Smectite
 Formation: -
 Location: Wyoming
 Condition 1: Saturated NaCl brine
 Condition 2: Ion used: Sr
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 170
 to: 200
 as: Hydrothermal alteration
 ranges from: Untreated to: 200 deg C,
 30 MPa
 Reference: Roy and Burns
 Source: Sci Basis for Waste Management - V
 (1982), p. 638

Property class: Sorption
 Material: Smectite (Ca)
 Formation: -
 Location: -
 Condition 1: Ions used: Ba, Cs, Eu, Sr
 Condition 2: Sources of variability: R-N
 conc, Ca conc
 Condition 3: -
 Property/units: Sorption coefficient (Kd)
 (ml/g)
 ranges from: 0.4
 to: $1.1 \times 10(4)$
 as: -
 ranges from: - to: -
 Reference: Shiao et al (1979)
 Source: ONWI-466 (1983), p. 73

Property class: Sorption
Material: Smectite (Na)

Formation: -

Location: -

Condition 1: Ions used: Am, Ba, Cf, Cm, Cs, Es, Eu, La, Sm, Sr, Yb

Condition 2: Sources of variability: Na conc, R-N conc, pH, temp, fluid comp

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 0.2
to: $1 \times 10(5)$

as: -

ranges from: - to: -

Reference: Three refs

Source: ONWI-486 (1983), p. 73

Property class: Sorption
Material: Vermiculite

Formation: -

Location: -

Condition 1: Ions used: Ba, Cs, Rb, Sr, Sr

Condition 2: Sources of variability: not stated

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 47
to: $1.5 \times 10(3)$

as: -

ranges from: - to: -

Reference: Two refs

Source: ONWI-486 (1983), p. 73

Property class: Sorption
Material: Vermiculite

Formation: -

Location: -

Condition 1: Varies with pH

Condition 2: -

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g?)

ranges from: ca. 40
to: $4 \times 10(4)$

as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1979), p. 315

Property class: Sorption
Material: Vermiculite

Formation: -

Location: -

Condition 1: pH = 8.5

Condition 2: Ions used = I, Tc, Np, Sr, Zr, Cs, Am, Sm, Pu

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g?)

ranges from: 30
to: $4 \times 10(6)$

as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1979a), p. 304

Property class: Sorption
Material: Vermiculite

Formation: -

Location: South Carolina

Condition 1: Saturated NaCl brine

Condition 2: Ion used: Cs

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: $8.9 \times 10(2)$
to: $1.01 \times 10(4)$

as: Hydrothermal alteration

ranges from: Untreated to: 200 deg C,
30 MPa

Reference: Roy and Burns

Source: Sci Basis for Waste Management - V (1982), p. 638

Property class: Sorption

Material: Vermiculite

Formation: -

Location: South Carolina

Condition 1: Saturated NaCl brine

Condition 2: Ion used: Sr

Condition 3: -

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: $2 \times 10(3)$
to: $9.8 \times 10(2)$

as: Hydrothermal alteration

ranges from: Untreated to: 200 deg C,
30 MPa

Reference: Roy and Burns

Source: Sci Basis for Waste Management - V (1982), p. 638

Property class: Sorption

Material: Vermiculite and Gibbsite

Formation: -

Location: -

Condition 1: Ions used: Ba, Cm, Rb, Sr

Condition 2: Sources of variability: not stated

Condition 3: 1:1 mixture

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 77
to: 1520

as: -

ranges from: - to: -

Reference: Komarneni and Roy (1980)

Source: ONWI-486 (1983), p. 73

Property class: Sorption

Material: Vermiculite and Shale

Formation: Conasauga Shale

Location: -

Condition 1: Ions used: Ba, Cm, Rb, Sr

Condition 2: Sources of variability: not stated

Condition 3: 1:1 mixture

Property/units: Sorption coefficient (Kd) (ml/g)

ranges from: 41
to: 1340

as: -

ranges from: - to: -

Reference: Komarneni and Roy (1980)

Source: ONWI-486 (1983), p. 73

Property class: Sorption
Material: Vermiculite and Smectite
Formation: -
Location: -
Condition 1: Ions used: Ba, Cm, Rb, Sr
Condition 2: Sources of variability: not stated
Condition 3: 1:1 mixture
Property/units: Sorption coefficient (Kd)
(ml/g)
ranges from: 192
to: 3800
as: -
ranges from: - to: -
Reference: Komarneni and Roy (1980)
Source: ONWI-486 (1983), p. 73

Property class: Sorption
Material: Vermiculite and Zeolite (various)
Formation: -
Location: -
Condition 1: Ions used: Ba, Cm, Rb, Sr
Condition 2: Sources of variability:
zeolite species
Condition 3: 1:1 mixture
Property/units: Sorption coefficient (Kd)
(ml/g)
ranges from: 130
to: $5.92 \times 10(5)$
as: -
ranges from: - to: -
Reference: Komarneni and Roy (1980)
Source: ONWI-486 (1983), p. 73

13.1.2 Appendix A.2. GENERAL PHYSICAL PROPERTIES

Property class: Density
 Material: Argillite
 Formation: Eleana Argillite
 Location: Nevada
 Condition 1: Quartz and illite dominant
 Condition 2: Lesser kaolinite, chamosite, etc.
 Condition 3: -
 Property/units: Density (bulk) (g/cm(3))
 ranges from: 2.44
 to: 2.71
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL/Sub/84-64794/1 (1985), p. 406

Property class: Density
 Material: Bentonite (a)
 Formation: -
 Location: -
 Condition 1: Pressed at 50 to 100 MPa
 Condition 2: Water content ca. 10%
 Condition 3: -
 Property/units: Density (bulk) (t/m(3)) (g/cm(3))
 ranges from: ca. 2.1
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Proc NEA Workshop OECD (1979b), p. 148

Property class: Density
 Material: Bentonite (a)
 Formation: -
 Location: Oregon
 Condition 1: 20 - 160 mesh
 Condition 2: -
 Condition 3: -
 Property/units: Specific gravity (g/cm(3))
 ranges from: 2.73
 to: -
 as: -
 ranges from: - to: -
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Density
 Material: Bentonite (b)
 Formation: -
 Location: Oregon
 Condition 1: Minus 200 mesh
 Condition 2: -
 Condition 3: -
 Property/units: Specific gravity (g/cm(3))
 ranges from: 2.85
 to: -
 as: -
 ranges from: - to: -
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Density
 Material: Bentonite (c)
 Formation: -
 Location: Wyoming
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Specific gravity (g/cm(3))
 ranges from: 2.77
 to: -
 as: -
 ranges from: - to: -
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Density
 Material: Bentonite (Ca)
 Formation: Panther Creek Clay
 Location: -
 Condition 1: Held at compaction pressure for one minute
 Condition 2: -
 Condition 3: -
 Property/units: Density (g/cm(3))
 ranges from: <1.7
 to: ca. 2.14
 as: Compaction pressure (MPa) and water content (%)
 ranges from: 55; <5 to: 221; ca. 8
 Reference: -
 Source: PNL-4452 UC-70 (1983), p. 24

Property class: Density
 Material: Bentonite (Na)
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: ADOPTED VALUE FOR CALCULATIONS
 Condition 3: -
 Property/units: Density (specific) (t/m(3)) (g/cm(3))
 ranges from: 2.7
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: KBS TEKNISK RAPPORT 74 (1978), p. 3

Property class: Density
 Material: Bentonite (Na) (a)
 Formation: -
 Location: -
 Condition 1: Plus 80 to 90% crushed quartzite, quartz sand, etc.
 Condition 2: Laboratory compaction
 Condition 3: -
 Property/units: Density (bulk) (t/m(3)) (g/cm(3))
 ranges from: 1.8
 to: 2.0
 as: -
 ranges from: - to: -
 Reference: -
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Property class: Density
 Material: Bentonite (Na) (a)

Formation: -

Location: -

Condition 1: Density maximum near 6% water
 Condition 2: Density varies with compaction pressure

Condition 3: -

Property/units: Density (g/cm(3))

ranges from: <1.8
 to: 2.28

as: Compaction pressure (MPa)

ranges from: 55 to: 221

Reference: -

Source: OMWI-312 (1981), p. 32

Property class: Density

Material: Bentonite (Na) (b)

Formation: -

Location: -

Condition 1: Plus 80 to 90% crushed
 quartzite, sand, etc.

Condition 2: Field compaction test

Condition 3: -

Property/units: Density (bulk) (ρ /m(3))
 (g/cm(3))

ranges from: 1.4
 to: 1.7

as: -

ranges from: - to: -

Reference: -

Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Property class: Density

Material: Bentonite (Na) (b)

Formation: -

Location: -

Condition 1: CS-50 Na-bentonite

Condition 2: Compaction for one minute

Condition 3: -

Property/units: Density (g/cm(3))

ranges from: <1.8
 to: ca. 2.5

as: Compaction pressure (MPa) and
 water content (%)

ranges from: 55; <2 to: 221; 5

Reference: -

Source: PNL-4452 UC-70 (1983), p. 21

Property class: Density

Material: Bentonite (Na) (c)

Formation: -

Location: Wyoming

Condition 1: MX-80

Condition 2: -

Condition 3: -

Property/units: Density (bulk) (ρ o \times ρ /m(3))
 (g/cm(3))

ranges from: 2.54
 to: 1.08

as: Water content (wt. %); void
 ratio (e)

ranges from: 3.7; 0.1 to: 741; 20.0

Reference: -

Source: KBS TEKNISK RAPPORT 74 (1978), p. 4

Property class: Density

Material: Bentonite (Na) and Sand (a)

Formation: -

Location: -

Condition 1: 75% clay

Condition 2: Held at compaction pressure
 for one minute

Condition 3: -

Property/units: Density (g/cm(3))

ranges from: <1.9
 to: ca. 2.8

as: Compaction pressure (MPa) and
 water content (%)

ranges from: 55; <3 to: 220; ca. 4

Reference: -

Source: PNL-4452 UC-70 (1983), p. 22

Property class: Density

Material: Bentonite (Na) and Sand (b)

Formation: -

Location: -

Condition 1: 50% bentonite

Condition 2: Held at pressure for one
 minute

Condition 3: -

Property/units: Density (g/cm(3))

ranges from: <1.9
 to: ca. 2.7

as: Compaction pressure (MPa) and
 water content (%)

ranges from: 55; <3 to: 276; ca. 8

Reference: -

Source: PNL-4452 UC-70 (1983), p. 23

Property class: Density

Material: Bentonite and Sand

Formation: -

Location: -

Condition 1: Dry

Condition 2: -

Condition 3: -

Property/units: Density (dry) (Mg/m(3))
 (g/cm(3))

ranges from: 1.81
 to: 1.4

as: Clay content (%)

ranges from: 22 to: 100

Reference: -

Source: AECL-7812 (1983), p. 31

Property class: Density

Material: Chlorite

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Density (dry) (presumed
 g/cm(3))

ranges from: 2.6
 to: 2.96

as: -

ranges from: - to: -

Reference: Grim (1968)

Source: Y/OWI/SUB-7009/1 (1976), p. 9

Property class: Density

Material: Clay

Formation: -

Location: Hanford

Condition 1: Ringold clay D

Condition 2: -

Condition 3: -

Property/units: Specific gravity (g/cm(3))

ranges from: 2.71

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Density

Material: Clay

Formation: Blue Clay

Location: Italy

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Density (bulk) (kg/m(3))

ranges from: 2100 (2.100 g/cm(3))

to: -

as: -

ranges from: - to: -

Reference: Chapman and Gera

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Property class: Density

Material: Clay

Formation: Boom Clay

Location: Belgium

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Density (bulk) (kg/m(3))

ranges from: 2010 (2.010 g/cm(3))

to: -

as: -

ranges from: - to: -

Reference: Chapman and Gera

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Property class: Density

Material: Clay

Formation: Oxford Clay

Location: England

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Density (bulk) (kg/m(3))

ranges from: 2210 (2.210 g/cm(3))

to: -

as: -

ranges from: - to: -

Reference: Chapman and Gera

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Property class: Density

Material: Clay

Formation: Porter's Creek Clay

Location: Louisiana

Condition 1: Smectite, kaolinite, illite, etc.

Condition 2: Quartz 5 to 50 %

Condition 3: -

Property/units: Density (kg/m(3))

ranges from: 1,954 (1.954 g/cm(3))

to: -

as: -

ranges from: - to: -

Reference: Boutwell (1980)

Source: ORNL/Sub/84-64794/1 (1985), p. 173

Property class: Density

Material: Clay and Sand

Formation: -

Location: -

Condition 1: Various bentonite sand mixtures

Condition 2: 10 - 70% clay by weight

Condition 3: -

Property/units: Density (dry) (kg/mg(3)) (?) (g/cm(3)) (?)

ranges from: ca. 1.6

to: ca. 2.2

as: Clay content (%) and moisture content (%)

ranges from: 70; ca. 20 - 27 to: 10;

ca. 5 - 15

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Density

Material: Clays and Shales

Formation: -

Location: Eastern US

Condition 1: Twenty-six determinations

Condition 2: -

Condition 3: -

Property/units: Density (grain) (average) (presumed g/cm(3))

ranges from: 2.69

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/SUB-7009/1 (1976), p. 10

Property class: Density

Material: Illite

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Density (presumed g/cm(3))

ranges from: 2.65

to: 2.13

as: Humidity (%)

ranges from: Dry to: 100

Reference: Grim (1968)

Source: Y/OWI/SUB-7009/1 (1976), p. 9

Property class: Density
 Material: Illite and Smectite
 Formation: -
 Location: -
 Condition 1: Mixed-layer with smectite
 Condition 2: -
 Condition 3: -
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.64
 to: 1.48
 as: Humidity (%)
 ranges from: Dry to: 100
 Reference: Grim (1968)
 Source: Y/OWI/SUB-7009/1 (1976), p. 9

Property class: Density
 Material: Kaolinite
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Density (dry) (Mg/m(3))
 (g/cm(3))
 ranges from: ca. 1.2
 to: ca. 1.5
 as: Moisture content (%)
 ranges from: 10 to: 25
 Reference: -
 Source: AECL-7812 (1983), p. 35

Property class: Density
 Material: Kaolinite
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.60 - 2.68
 to: 2.43
 as: Humidity (%)
 ranges from: Dry to: 100
 Reference: Grim (1968)
 Source: Y/OWI/SUB-7009/1 (1976), p. 9

Property class: Density
 Material: Kaolinite and Sand
 Formation: -
 Location: -
 Condition 1: Dry
 Condition 2: -
 Condition 3: -
 Property/units: Density (dry) (Mg/m(3))
 (g/cm(3))
 ranges from: 2.05
 to: 1.45
 as: Clay content (%)
 ranges from: 22 to: 100
 Reference: -
 Source: AECL-7812 (1983), p. 31

Property class: Density
 Material: Oil Shales
 Formation: Green River Fm
 Location: -
 Condition 1: Mahogany zone
 Condition 2: -
 Condition 3: -
 Property/units: Density (bulk) (presumed
 g/cm(3))
 ranges from: 1.506
 to: 2.37
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 13

Property class: Density
 Material: Shale
 Formation: -
 Location: California
 Condition 1: Pliocene
 Condition 2: Depth: 5,000 to 6,000 feet
 Condition 3: -
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.5
 to: -
 as: Water content (%)
 ranges from: 6 to: -
 Reference: McCulloch (1967)
 Source: Y/OWI/SUB-7009/1 (1976), p. 12

Property class: Density
 Material: Shale
 Formation: Antrim Shale
 Location: Michigan
 Condition 1: Quartz dominant
 Condition 2: Illite, kaolinite
 Condition 3: -
 Property/units: Density (bulk) (g/cm(3))
 ranges from: 2.2
 to: 2.8
 as: -
 ranges from: - to: -
 Reference: Young (1978)
 Source: ORNL/Sub/84-64794/1 (1985), p. 96

Property class: Density
 Material: Shale
 Formation: Bearpaw Shale
 Location: Montana
 Condition 1: Upper Cretaceous
 Condition 2: Depth from 180 to 200 feet
 Condition 3: -
 Property/units: Density (dry) (average)
 (lbs/ft(3))
 ranges from: 118 (1.890 g/cm(3))
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 6-1

Property class: Density
 Material: Shale
 Formation: Bearpaw Shale
 Location: Montana
 Condition 1: Upper Cretaceous
 Condition 2: Depth from 180 to 200 feet
 Condition 3: -
 Property/units: Density (wet) (average)
 (pounds/ft³)
 ranges from: 135 (2.162 g/cm³)
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 6-1

Property class: Density
 Material: Shale
 Formation: New Albany Shale
 Location: Illinois, Indiana, and
 Kentucky
 Condition 1: Devonian and Mississippian
 Condition 2: Five coreholes
 Condition 3: Illite:chlorite = 2:1
 Property/units: Density (bulk) (average)
 (g/cm³)
 ranges from: 2.36
 to: 2.53
 as: -
 ranges from: - to: -
 Reference: Several refs
 Source: ORNL-5703 (1983), p. 76

Property class: Density
 Material: Shale
 Formation: Olentangy and Huron Shales
 Location: Ohio
 Condition 1: Illite dominant
 Condition 2: Several samples
 Condition 3: -
 Property/units: Density (bulk) (g/cm³)
 ranges from: 2.65
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL/Sub/84-64794/1 (1985), p. 108

Property class: Density
 Material: Shale
 Formation: Pierre Shale
 Location: Northern Great Plains
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Density (dry) (lb/cu ft)
 ranges from: 95 (1.522 g/cm³)
 to: 110 (1.762 g/cm³)
 as: -
 ranges from: - to: -
 Reference: Abel and Gentry (1975)
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Density
 Material: Shale (a)
 Formation: -
 Location: -
 Condition 1: Miocene
 Condition 2: -
 Condition 3: -
 Property/units: Density (bulk) (presumed)
 g/cm³)
 ranges from: 2.1
 to: 2.5
 as: Water content (%); depth (ft)
 ranges from: 31; 6,000 to: 4; 16,000
 Reference: Kerr and Barrington (1961)
 Source: Y/OWI/SUB-7009/1 (1976), p. 12

Property class: Density
 Material: Shale (a)
 Formation: -
 Location: -
 Condition 1: Summary
 Condition 2: -
 Condition 3: -
 Property/units: Density (kg/m³)
 ranges from: 2,123 (2.123 g/cm³)
 to: 3,003 (3.003 g/cm³)
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL-6241/V1 (in preparation) p. 40

Property class: Density
 Material: Shale (b)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Density (grain) (averag.)
 (presumed g/cm³)
 ranges from: 2.71
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 10

Property class: Density
 Material: Shale (b)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Density (kg/m³)
 ranges from: 2,563 (2.563 g/cm³)
 to: -
 as: -
 ranges from: - to: -
 Reference: Loken, M. (personal communication)
 (1984)
 Source: ORNL-6241/V2 (in preparation) p. 99

Property class: Density
 Material: Shale (c)
 Formation: -
 Location: -
 Condition 1: Paleozoic
 Condition 2: Deep burial
 Condition 3: Expanded
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.4
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Property class: Density
 Material: Shale (d)
 Formation: -
 Location: -
 Condition 1: Paleozoic
 Condition 2: Deep burial
 Condition 3: Non-expanded
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.65
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Property class: Density
 Material: Shale (e)
 Formation: -
 Location: -
 Condition 1: Paleozoic
 Condition 2: Shallow burial
 Condition 3: Expanded
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.2
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Property class: Density
 Material: Shale (f)
 Formation: -
 Location: -
 Condition 1: Paleozoic
 Condition 2: Shallow burial
 Condition 3: Non-expanded
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.3
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Property class: Density
 Material: Shale (g)
 Formation: -
 Location: -
 Condition 1: Tertiary
 Condition 2: Deep burial
 Condition 3: Expanded
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.2
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Property class: Density
 Material: Shale (h)
 Formation: -
 Location: -
 Condition 1: Tertiary
 Condition 2: Deep burial
 Condition 3: Non-expanded
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.5
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Property class: Density
 Material: Shale (i)
 Formation: -
 Location: -
 Condition 1: Tertiary
 Condition 2: Shallow burial
 Condition 3: Expanded
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.0
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Property class: Density
 Material: Shale (j)
 Formation: -
 Location: Gulf Coast
 Condition 1: Oligocene
 Condition 2: -
 Condition 3: -
 Property/units: Density (g/cm(3))
 ranges from: 2.1
 to: 2.3
 as: Porosity (%); Depth (feet)
 ranges from: 22; 2,000 to: 12; 10,000
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 121

Property class: Density
 Material: Shale (k)
 Formation: -
 Location: Gulf Coast
 Condition 1: Eocene
 Condition 2: Depth 8,600 feet
 Condition 3: -
 Property/units: Density (presumed g/cm(3))
 ranges from: 2.58
 to: -
 as: Water content (%)
 ranges from: 1.3 to: -
 Reference: Dickinson (1953)
 Source: Y/OWI/SUB-7009/1 (1976), p. 12

Property class: Density
 Material: Shales
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Density (dry) (presumed g/cm(3))
 ranges from: 1.55
 to: 2.55
 as: Depth (feet)
 ranges from: 0 to: 11,000
 Reference: Skeels (year not stated)
 Source: Y/OWI/SUB-7009/1 (1976), Fig. 1

Property class: Density
 Material: Shales
 Formation: -
 Location: -
 Condition 1: Represents many tests
 Condition 2: -
 Condition 3: -
 Property/units: Density (lbs/ft(3))
 ranges from: 117 (1.874 g/cm(3))
 to: 188 (3.011 g/cm(3))
 as: -
 ranges from: - to: -
 Reference: Several refs
 Source: Y/OWI/TM36/6, p. A-2, 3 & 4

Property class: Density
 Material: Shales
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Density (wet) (presumed g/cm(3))
 ranges from: 1.98
 to: 2.67
 as: Depth (feet)
 ranges from: 0 to: 11,000
 Reference: Skeels (year not stated)
 Source: Y/OWI/SUB-7009/1 (1976), Fig. 1

Property class: Density
 Material: Shales
 Formation: -
 Location: Black Hills
 Condition 1: Cretaceous
 Condition 2: Nine determinations
 Condition 3: -
 Property/units: Density (grain) (average) (presumed g/cm(3))
 ranges from: 2.66
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 10

Property class: Density
 Material: Shales
 Formation: -
 Location: Eastern Canada
 Condition 1: Cretaceous
 Condition 2: Illite dominant plus chlorite, quartz, smectite, etc.
 Condition 3: -
 Property/units: Density (bulk) (presumed g/cm(3))
 ranges from: 2.07
 to: 2.68
 as: Depth (feet)
 ranges from: 2,698 to: 9,120
 Reference: Kaarsberg (1959)
 Source: Y/OWI/SUB-7009/1 (1976), p. 15

Property class: Density
 Material: Shales
 Formation: -
 Location: Kansas
 Condition 1: Paleozoic and Mesozoic
 Condition 2: Twenty-five determinations
 Condition 3: -
 Property/units: Density (grain) (average) (presumed g/cm(3))
 ranges from: 2.72
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 10

Property class: Density
 Material: Shales
 Formation: -
 Location: New York, Kentucky, Virginia and West Virginia
 Condition 1: Devonian
 Condition 2: -
 Condition 3: -
 Property/units: Density (bulk) (average) (g/cm(3))
 ranges from: 2.61
 to: 2.68
 as: -
 ranges from: - to: -
 Reference: Several refs
 Source: ORNL-5703 (1983), p. 37

Property class: Density
Material: Shales
 Formation: -
 Location: Oklahoma
 Condition 1: Permian and Pennsylvanian
 Condition 2: -
 Condition 3: -
Property/units: Density (bulk) (presumed g/cm(3))
 ranges from: 2.1
 to: 2.62
 as: Depth (feet)
 ranges from: 400 to: 5,000
Reference: Athey (1930)
Source: Y/OWI/SUB-7009/1 (1976), p. 16

Property class: Density
Material: Shales
 Formation: -
 Location: Venezuela
 Condition 1: Tertiary
 Condition 2: Forty determinations
 Condition 3: -
Property/units: Density (grain) (average) (presumed g/cm(3))
 ranges from: 2.69
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/SUB-7009/1 (1976), p. 10

Property class: Density
Material: Shales
 Formation: Graneros, Greenhorn, Niobrara and Pierre Shales
 Location: Black Hills
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Density (bulk) (presumed g/cm(3))
 ranges from: 1.559
 to: 2.038
 as: -
 ranges from: - to: -
Reference: Rubey (1930)
Source: Y/OWI/SUB-7009/1 (1976), p. 14

Property class: Density
Material: Shales
 Formation: Ireton Fm
 Location: Western Canada
 Condition 1: Devonian
 Condition 2: Illite plus chlorite
 Condition 3: Some calcite and dolomite
Property/units: Density (bulk) (presumed g/cm(3))
 ranges from: 2.43
 to: 2.71
 as: Depth (feet)
 ranges from: 2,770 to: 6,565
Reference: Kaarsberg (1959)
Source: Y/OWI/SUB-7009/1 (1976), p. 17

Property class: Density
Material: Shales (a)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Density (bulk) (g/cm(3))
 ranges from: 1.6
 to: 2.5
 as: Depth (m)
 ranges from: 0 to: 6000
Reference: Several refs
Source: ORNL-6241/V2 (In preparation) p. 199

Property class: Density
Material: Shales (b)
 Formation: -
 Location: -
 Condition 1: Pennsylvanian
 Condition 2: Three samples
 Condition 3: -
Property/units: Density (bulk) (presumed g/cm(3))
 ranges from: 2.40
 to: 2.43
 as: Water content (%)
 ranges from: 12 to: 11
Reference: Kaarsberg (1959)
Source: Y/OWI/SUB-7009/1 (1976), p. 16

Property class: Density
Material: Shales (c)
 Formation: -
 Location: -
 Condition 1: Mississippian-Devonian
 Condition 2: -
 Condition 3: -
Property/units: Density (natural) (presumed g/cm(3))
 ranges from: 2.43
 to: 2.65
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/SUB-7009/1 (1976), p. 18

Property class: Density
Material: Smectite
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Density (presumed g/cm(3))
 ranges from: 2.2-2.7
 to: 1.77
 as: Humidity (%)
 ranges from: Dry to: 100
Reference: Grim (1968)
Source: Y/OWI/SUB-7009/1 (1976), p. 9

Property class: Moisture content
 Material: Argillite
 Formation: Eleana Argillite
 Location: Nevada
 Condition 1: Quartz and illite dominant
 Condition 2: Lesser kaolinite, chamosite, etc.
 Condition 3: -
 Property/units: Moisture content (%)
 ranges from: 2
 to: 4
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL/Sub/84-64794/1 (1985), p. 406

Property class: Moisture content
 Material: Bentonite and Sand
 Formation: -
 Location: -
 Condition 1: Moist
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (%)
 ranges from: 13
 to: 22
 as: Clay content (%)
 ranges from: 22 to: 100
 Reference: -
 Source: AECL-7812 (1983), p. 31

Property class: Moisture content
 Material: Kaolinite and Sand
 Formation: -
 Location: -
 Condition 1: Moist
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (%)
 ranges from: 10
 to: 30
 as: Clay content (%)
 ranges from: 22 to: 100
 Reference: -
 Source: AECL-7812 (1983), p. 31

Property class: Moisture content
 Material: Shale
 Formation: Arnheim and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3: -
 Property/units: Moisture content (natural) (%)
 ranges from: 2
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 5-14

Property class: Moisture content
 Material: Shale
 Formation: Bearpaw Shale
 Location: Montana
 Condition 1: Upper Cretaceous
 Condition 2: Depth from 180 to 200 feet
 Condition 3: -
 Property/units: Water content (average) (%)
 ranges from: 15
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 6-1

Property class: Moisture content
 Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3: -
 Property/units: Moisture content (natural) (%)
 ranges from: 4
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 4-12

Property class: Moisture content
 Material: Shale
 Formation: Lewis Shale
 Location: New Mexico
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (%)
 ranges from: 3.7
 to: 6.2
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 8-5

Property class: Moisture content
 Material: Shale
 Formation: Mancos Fm
 Location: New Mexico
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (rock) (%)
 ranges from: 3
 to: 11
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 8-3

Property class: Moisture content
 Material: Shale (a)
 Formation: -
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (natural) (%)
 ranges from: 0 to: 38
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 2-2

Property class: Moisture content
 Material: Shale (b)
 Formation: -
 Location: -
 Condition 1: "Typical" lilitic
 Condition 2: Intact
 Condition 3: -
 Property/units: Moisture content (natural) (%)
 ranges from: 1.5 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 7-8

Property class: Moisture content
 Material: Shale (c)
 Formation: Pierre Shale
 Location: -
 Condition 1: Cretaceous
 Condition 2: Intact
 Condition 3: -
 Property/units: Moisture content (natural) (%)
 ranges from: 18 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6, p. 3-24

Property class: Moisture content
 Material: Shale (d)
 Formation: Pierre Shale
 Location: Northern Great Plains
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (natural) (%)
 ranges from: 18 to: 38
 as: -
 ranges from: - to: -
 Reference: Abel and Gentry (1975)
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Moisture content
 Material: Shale (e)
 Formation: Pierre Shale
 Location: Western USA
 Condition 1: Cretaceous
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (%)
 ranges from: 35 to: 15
 as: Depth
 ranges from: "Near surface" to: "Deeply buried"
 Reference: -
 Source: Y/OWI/TM36/6, p. 3-1

Property class: Moisture content
 Material: Shales
 Formation: Pierre, Bearpaw and Claggett Shales
 Location: -
 Condition 1: Porosities stabilize at 200 to 300 feet depth
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (natural) (%)
 ranges from: 38 to: 12
 as: Porosity (%)
 ranges from: 61 to: 26
 Reference: Abel and Gentry (1975)
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Property class: Moisture content
 Material: Shales (a)
 Formation: -
 Location: -
 Condition 1: Represents many tests
 Condition 2: -
 Condition 3: -
 Property/units: Moisture content (%)
 ranges from: 1.3 to: 38
 as: -
 ranges from: - to: -
 Reference: Several refs
 Source: Y/OWI/TM36/6, p. A-13, 14 & 15

Property class: Moisture content
 Material: Shales (b)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Water content (vol %)
 ranges from: 70 to 90 to: 5 to 10
 as: Depth (m)
 ranges from: 0 to: 1,000
 Reference: Burst (1969)
 Source: ORNL-6241/V2 (in preparation) p. 218

Property class: Porosity
Material: Argillite
 Formation: Eleiana Argillite
 Location: Nevada
 Condition 1: Quartz and illite dominant
 Condition 2: Lesser kaolinite, chamosite, etc.
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 8 to 16
 to: 6 to 12
 as: Depth (m)
 ranges from: <500 to: 500-914
Reference: -
Source: ORNL/Sub/84-64794/1 (1985), p. 406

Property class: Porosity
Material: Bentonite and Sand
 Formation: -
 Location: -
 Condition 1: Various bentonite:sand ratios
 Condition 2: -
 Condition 3: -
Property/units: Porosity (effective) (units not stated)
 ranges from: ca. 0.4
 to: 0.002
 as: Density (dry) (Mg/m³)
 ranges from: 1.2 to: 1.8 to 2.4
Reference: -
Source: AECL-7812 (1983), p. 32

Property class: Porosity
Material: Clay
 Formation: Blue Clay
 Location: Italy
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 25
 to: -
 as: -
 ranges from: - to: -
Reference: Chapman and Gera
Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Property class: Porosity
Material: Clay
 Formation: Boom Clay
 Location: Belgium
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 38.5
 to: -
 as: -
 ranges from: - to: -
Reference: Chapman and Gera
Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Property class: Porosity
Material: Clay
 Formation: Oxford Clay
 Location: England
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 30
 to: -
 as: -
 ranges from: - to: -
Reference: Chapman and Gera
Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Property class: Porosity
Material: Illite
 Formation: -
 Location: -
 Condition 1: Specific surface = 8 hm²/kg
 Condition 2: -
 Condition 3: -
Property/units: Porosity (effective) (units not stated)
 ranges from: ca. 0.5
 to: ca. 0.002
 as: Density (dry) (Mg/m³)
 ranges from: 1.2 to: 2.6
Reference: -
Source: AECL-7812 (1983), p. 32

Property class: Porosity
Material: Kaolinite
 Formation: -
 Location: -
 Condition 1: Specific surface = 2 hm²/kg
 Condition 2: -
 Condition 3: -
Property/units: Porosity (effective) (units not stated)
 ranges from: ca. 0.5
 to: ca. 0.002
 as: Density (dry) (Mg/m³)
 ranges from: 1.2 to: 2.6
Reference: -
Source: AECL-7812 (1983), p. 32

Property class: Porosity
Material: Shale
 Formation: -
 Location: -
 Condition 1: ADOPTED BASE VALUE
 Condition 2: -
 Condition 3: -
Property/units: Porosity (effective) (units not stated)
 ranges from: 0.05
 to: 0.005
 as: -
 ranges from: - to: -
Reference: -
Source: ORNL-6241/V1 (in preparation) p. 33

Property class: Porosity
Material: Shale
 Formation: -
 Location: -
 Condition 1: "Typical" Iilitic
 Condition 2: Intact
 Condition 3: -
Property/units: Porosity (rock mass) (%)
 ranges from: 3.0
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6, p. 7-8

Property class: Porosity
Material: Shale
 Formation: -
 Location: -
 Condition 1: ADOPTED BASE VALUE
 Condition 2: -
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.1
 to: 0.01
 as: -
 ranges from: - to: -
Reference: -
Source: ORNL-6241/V1 (in preparation) p. 33

Property class: Porosity
Material: Shale
 Formation: -
 Location: Great Britain
 Condition 1: Silurian
 Condition 2: Five outcrop samples
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.020
 to: 0.101
 as: -
 ranges from: - to: -
Reference: Menger (1963)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: -
 Location: Michigan
 Condition 1: Devonian
 Condition 2: -
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.03
 to: 0.10
 as: -
 ranges from: - to: -
Reference: Gonzales (1984)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: -
 Location: South Carolina
 Condition 1: Triassic
 Condition 2: Dumbarton Basin
 Condition 3: -
Property/units: Porosity (effective) (units not stated)
 ranges from: 0.005
 to: -
 as: -
 ranges from: - to: -
Reference: Gonzales (1984)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: Arnheim and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3: -
Property/units: Porosity (effective) (%)
 ranges from: 4
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6, p. 5-14

Property class: Porosity
Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3: -
Property/units: Porosity (rock mass) (%)
 ranges from: 8
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6, p. 4-12

Property class: Porosity
Material: Shale
 Formation: Chanute Shale
 Location: Kansas
 Condition 1: Pennsylvanian
 Condition 2: Four samples
 Condition 3: 230-m depth
Property/units: Porosity (total) (units not stated)
 ranges from: 0.073
 to: 0.106
 as: -
 ranges from: - to: -
Reference: Menger (1963)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: Chattanooga Shale
 Location: Kentucky
 Condition 1: Devonian
 Condition 2: Two subsurface samples
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.074
 to: 0.076
 as: -
 ranges from: - to: -
Reference: Manger (1963)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: Conasauga Shale
 Location: Tennessee
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 0.5
 to: 1.9
 as: -
 ranges from: - to: -
Reference: DeLaguna (1968)
Source: ORNL-6241/V2 (in preparation) p. 219

Property class: Porosity
Material: Shale
 Formation: Conasauga Shale
 Location: Tennessee
 Condition 1: Cambrian
 Condition 2: Five samples
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.005
 to: 0.019
 as: -
 ranges from: - to: -
Reference: DeLaguna (1968)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: Hamilton Shale
 Location: Missouri
 Condition 1: Mississippian
 Condition 2: One outcrop sample
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.113
 to: -
 as: -
 ranges from: - to: -
Reference: Manger (1963)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: Martinsburg Shale
 Location: Pennsylvania
 Condition 1: Ordovician
 Condition 2: Quarry sample
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.010
 to: -
 as: -
 ranges from: - to: -
Reference: Manger (1963)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: Muddy Shale
 Location: Colorado
 Condition 1: Depth 4,900 feet
 Condition 2: -
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 4.1
 to: 5.1
 as: -
 ranges from: - to: -
Reference: Handin et al. (1963)
Source: Y/OWI/SUB-7009/1 (1976), p. 14

Property class: Porosity
Material: Shale
 Formation: New Albany Shale
 Location: Illinois, Indiana, Kentucky
 Condition 1: Devonian
 Condition 2: -
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.009
 to: 0.046
 as: -
 ranges from: - to: -
Reference: Gonzales (1984)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale
 Formation: Olentangy and Huron Shale
 Location: Ohio
 Condition 1: Devonian and Mississippian
 Condition 2: Illite dominant
 Condition 3: -
Property/units: Porosity (primary) (%)
 ranges from: >3 %
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: ORNL/Sub/84-64794/1 (1985), p. 108

Property class: Porosity

Material: Shale

Formation: Ophir Shale

Location: Utah

Condition 1: Cambrian

Condition 2: Two subsurface samples

Condition 3: -

Property/units: Porosity (total) (units not stated)

ranges from: 0.009

to: -

as: -

ranges from: - to: -

Reference: Manger (1963)

Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity

Material: Shale

Formation: Pierre Shale

Location: -

Condition 1: Cretaceous

Condition 2: Intact

Condition 3: -

Property/units: Porosity (%)

ranges from: 33

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6, p. 3-24

Property class: Porosity

Material: Shale (a)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 30

to: 5 to 10

as: Depth (m)

ranges from: 500 to: 2,500

Reference: Conybeare (1967)

Source: ORNL-6241/V2 (in preparation) p. 218

Property class: Porosity

Material: Shale (a)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Porosity (effective) (units not

ranges from: 0.01

to: -

as: -

ranges from: - to: -

Reference: Loken, M. (personal communication)

(1984)

Source: ORNL-6241/V2 (in preparation) p. 99

Property class: Porosity

Material: Shale (a)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Porosity (total) (units not stated)

ranges from: 0.03

to: -

as: -

ranges from: - to: -

Reference: Loken, M. (personal communication) (1984)

Source: ORNL-6241/V2 (in preparation) p. 99

Property class: Porosity

Material: Shale (a)

Formation: Antrim Shale

Location: Michigan

Condition 1: Devonian

Condition 2: Depth from 350 to 450 m

Condition 3: -

Property/units: Porosity (%)

ranges from: 3

to: 10

as: -

ranges from: - to: -

Reference: Two refs

Source: ORNL-5703 (1983), p. 106

Property class: Porosity

Material: Shale (a)

Formation: New Albany Shale

Location: Illinois, Indiana and

Kentucky

Condition 1: Devonian and Mississippian

Condition 2: Four coreholes

Condition 3: -

Property/units: Porosity (average) (vol. %)

ranges from: 0.95

to: 4.64

as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-5703 (1983), p. 76

Property class: Porosity

Material: Shale (b)

Formation: -

Location: -

Condition 1: Intact

Condition 2: -

Condition 3: -

Property/units: Porosity (rock mass) (%)

ranges from: 0

to: 45

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6, p. 2-2

Property class: Porosity
Material: Shale (b)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.03
 to: -
 as: -
 ranges from: - to: -
Reference: D'Appalonia (1980)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale (b)
 Formation: Antrim Shale
 Location: Michigan
 Condition 1: Quartz dominant
 Condition 2: Illite and kaolinite
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 3
 to: 10
 as: -
 ranges from: - to: -
Reference: Young (1978)
Source: ORNL/Sub/84-64794/1 (1985), p. 98

Property class: Porosity
Material: Shale (b)
 Formation: New Albany Shale
 Location: Illinois, Indiana, Kentucky
 Condition 1: Black shale
 Condition 2: Quartz dominant
 Condition 3: Illite:chlorite = 2:1
Property/units: Porosity (%)
 ranges from: 0.95
 to: 4.64
 as: -
 ranges from: - to: -
Reference: Kalyoncu et al (1979)
Source: ORNL/Sub/84-64794/1 (1985), p. 85

Property class: Porosity
Material: Shale (c)
 Formation: -
 Location: -
 Condition 1: Two samples
 Condition 2: -
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.003
 to: 0.056
 as: -
 ranges from: - to: -
Reference: Panday (1974)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale (d)
 Formation: -
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Appalachian Basin Shale
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.03
 to: -
 as: -
 ranges from: - to: -
Reference: Gonzales (1984)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale (e)
 Formation: -
 Location: Pennsylvania
 Condition 1: Devonian
 Condition 2: Gas shale
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.0117
 to: -
 as: -
 ranges from: - to: -
Reference: U. S. DOE (1981)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shale (f)
 Formation: -
 Location: Scotland
 Condition 1: Carboniferous
 Condition 2: Outcrop sample
 Condition 3: -
Property/units: Porosity (total) (units not stated)
 ranges from: 0.016
 to: -
 as: -
 ranges from: - to: -
Reference: Manger (1963)
Source: ORNL-6241/V2 (in preparation) p. 52

Property class: Porosity
Material: Shales
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Porosity (%)
 ranges from: 70
 to: 10
 as: Depth (m)
 ranges from: 0 to: 6,000
Reference: Several refs
Source: ORNL-6241/V2 (in preparation) p. 199

Property class: Porosity

Material: Shales

Formation: -

Location: Appalachian Basin

Condition 1: Devonian

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: ca. 3

to: -

as: -

ranges from: - to: -

Reference: Gonzales and Johnson (1984)

Source: ORNL-6241/V2 (in preparation) p. 219

Property class: Porosity

Material: Shales

Formation: -

Location: Illinois Basin

Condition 1: Devonian

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 0.9

to: 4.6

as: -

ranges from: - to: -

Reference: Gonzales and Johnson (1984)

Source: ORNL-6241/V2 (in preparation) p. 219

Property class: Porosity

Material: Shales

Formation: -

Location: Kentucky (a)

Condition 1: Pennsylvanian

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 3.3

to: 10.1

as: Depth (m)

ranges from: ca. 450 to: -

Reference: Gipson (1966)

Source: ORNL-6241/V2 (in preparation) p. 219

Property class: Porosity

Material: Shales

Formation: -

Location: Kentucky (b)

Condition 1: Pennsylvanian

Condition 2: Porosity decreases with depth

Condition 3: Porosity decreases with preferred orientation

Property/units: Porosity (%)

ranges from: 15

to: 3

as: Depth (feet); Water content (%)

ranges from: 31; 6 to: 1,484; 1

Reference: Gipson (1966)

Source: Y/OWI/SUB-7009/1 (1976), p. 16

Property class: Porosity

Material: Shales

Formation: -

Location: Kentucky, New York, Virginia and West Virginia

Condition 1: Devonian

Condition 2: -

Condition 3: -

Property/units: Porosity (average) (vol. %)

ranges from: 2.86 to 3.87

to: -

as: -

ranges from: - to: -

Reference: Several refs

Source: ORNL-5703 (1983), p. 37

Property class: Porosity

Material: Shales

Formation: -

Location: Michigan Basin

Condition 1: Devonian

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 3

to: 10

as: -

ranges from: - to: -

Reference: Gonzales and Johnson (1984)

Source: ORNL-6241/V2 (in preparation) p. 219

Property class: Porosity

Material: Shales

Formation: -

Location: Oklahoma

Condition 1: Pennsylvanian and Permian

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 25

to: 2

as: Depth (feet)

ranges from: 400 to: 5,000

Reference: Athey (1930)

Source: Y/OWI/SUB-7009/1 (1976), p. 16

Property class: Porosity

Material: Shales

Formation: -

Location: Pennsylvania

Condition 1: Devonian

Condition 2: -

Condition 3: -

Property/units: Porosity (effective) (%)

ranges from: 1.17

to: -

as: -

ranges from: - to: -

Reference: U. S. DOE (1981)

Source: ORNL-6241/V2 (in preparation) p. 219

Property class: Porosity

Material: Shales

Formation: -

Location: South Carolina

Condition 1: Triassic

Condition 2: -

Condition 3: -

Property/units: Porosity (effective) (%)

ranges from: ca. 0.5

to: -

as: -

ranges from: - to: -

Reference: U. S. DOE (1981)

Source: ORNL-6241/V2 (In preparation) p. 219

Property class: Porosity

Material: Shales

Formation: -

Location: USA and Europe

Condition 1: Outcrops, mines and boreholes

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 19

to: 1

as: -

ranges from: - to: -

Reference: Manger (1963)

Source: ORNL-6241/V2 (In preparation) p. 219

Property class: Porosity

Material: Shales (a)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 3

to: 15

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V2 (In preparation) p. 218

Property class: Porosity

Material: Shales (b)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 15 to 45

to: 3 to 20

as: Depth (m)

ranges from: 600 to: 3,000

Reference: Rieke (1974)

Source: ORNL-6241/V2 (In preparation) p. 219

Property class: Porosity

Material: Shales (c)

Formation: -

Location: -

Condition 1: Mississippian and Devonian

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 0.4

to: 7.2

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/SUB-7009/1 (1976), p. 18

Property class: Porosity

Material: Shales (d)

Formation: -

Location: -

Condition 1: Represents many samples

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 0.0

to: 44.8

as: -

ranges from: - to: -

Reference: Several refs

Source: Y/OWI/TM36/6, p. A-12

Property class: Porosity

Material: Shales (e)

Formation: -

Location: Germany

Condition 1: Triassic

Condition 2: -

Condition 3: -

Property/units: Porosity (%)

ranges from: 25

to: ca. 0

as: Depth (feet); Water content (%)

ranges from: 400; 11 to: 4,000; ca. 0

Reference: Muller (1967)

Source: Y/OWI/SUB-7009/1 (1976), p. 15

Property class: Specific gravity

Material: Bentonite (a)

Formation: -

Location: -

Condition 1: Avonigel

Condition 2: Air dry moisture content = 9.3%

Condition 3: -

Property/units: Specific gravity

(dimensionless)

ranges from: 2.21

to: -

as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 340

Property class: Specific gravity
Material: Bentonite (b)
 Formation: -
 Location: Black Hills
 Condition 1: Air dry moisture content = 8.3%
 Condition 2: -
 Condition 3: -
Property/units: Specific gravity (dimensionless)
 ranges from: 2.18
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Proc NEA Workshop OECD (1981), p. 340

Property class: Specific gravity
Material: Bentonite (Na)
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: -
 Condition 3: -
Property/units: Specific gravity (dimensionless)
 ranges from: 2.66
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: AECL-7825 (1984), p. 12

Property class: Specific gravity
Material: Bentonite (Na) and Sand
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: 50% sand
 Condition 3: -
Property/units: Specific gravity (dimensionless)
 ranges from: 2.635
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: AECL-7825 (1984), p. 12

Property class: Specific gravity
Material: Bentonite (Na) and Sand
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: 50% sand
 Condition 3: -
Property/units: Specific gravity (dimensionless)
 ranges from: 2.66
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: AECL-7825 (1984), p. 12

Property class: Specific gravity
Material: Kaolinite
 Formation: -
 Location: -
 Condition 1: Air dry moisture content = 1.1%
 Condition 2: -
 Condition 3: -
Property/units: Specific gravity (dimensionless)
 ranges from: 2.60
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Proc NEA Workshop OECD (1981), p. 340

Property class: Specific surface
Material: Bentonite (Na)
 Formation: -
 Location: -
 Condition 1: Specific gravity = 2.66
 Condition 2: Organic content (dry) (%) = 2.5
 Condition 3: -
Property/units: Specific surface (m²/g)
 ranges from: 519
 to: 615
 as: -
 ranges from: - to: -
Reference: -
Source: AECL-7825 (1984), p. 12

Property class: Specific surface
Material: Bentonite (Na) and Sand
 Formation: -
 Location: -
 Condition 1: 50% bentonite
 Condition 2: Specific gravity = 2.635
 Condition 3: Organic content (%) = 0.1
Property/units: Specific surface (m²/g)
 ranges from: 284
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: AECL-7825 (1984), p. 12

Property class: Specific surface
Material: Shale
 Formation: Antrim Shale
 Location: Michigan
 Condition 1: Devonian
 Condition 2: Typically 50-60% quartz, 20-35% illite
 Condition 3: Values may be inaccurate because of method used
Property/units: Specific surface (m²/g)
 ranges from: 0.05
 to: 1.2
 as: -
 ranges from: - to: -
Reference: -
Source: ORNL-5703 (1983), p. 109

Property class: Specific surface
Material: Smectite
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Specific surface (m²/g)
 ranges from: 800
 to: -
 as: -
 ranges from: - to: -
Reference: Two refs
Source: NUREG/CP-0052 (1983), p. 182

Property class: Void ratio
 Material: Clays

Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Void ratio (dimensionless)
 ranges from: ca. 1.5 to 3.0
 to: ca. 0.5 to 0.6
 as: Effective overburden pressure
 (kg/cm²)
 ranges from: 0.1 (0.01 MPa)
 to: 110 (10.8 MPa)

Reference: Skempton (1953)
 Source: ONWI-312 (1981), p. 21

Property class: Void ratio
 Material: Kaolinite (Ca)

Formation: -
 Location: -
 Condition 1: Water saturated.
 Condition 2: -
 Condition 3: -

Property/units: Void ratio (dimensionless)
 ranges from: 2.5
 to: 1.0
 as: Pressure
 ranges from: 100 psf (0.05 MPa) to:
 100,000 psf (4.7 MPa)

Reference: Olson and Mesri (1970)
 Source: ONWI-486 (1983), p. 38

Property class: Void ratio

Material: Kaolinite (Na)

Formation: -
 Location: -
 Condition 1: Water saturated.
 Condition 2: -
 Condition 3: -

Property/units: Void ratio (dimensionless)
 ranges from: 2.5
 to: 1.0
 as: Pressure
 ranges from: 100 psf (0.05 MPa) to:
 100,000 psf (4.7 MPa)

Reference: Olson and Mesri (1970)
 Source: ONWI-486 (1983), p. 38

Property class: Void ratio

Material: Smectite (Ca)

Formation: -
 Location: -
 Condition 1: Water saturated.
 Condition 2: -
 Condition 3: -

Property/units: Void ratio (dimensionless)
 ranges from: 7.0
 to: 1.0
 as: Pressure
 ranges from: 100 psf (0.05 MPa) to:
 100,000 psf (4.7 MPa)

Reference: Olson and Mesri (1970)
 Source: ONWI-486 (1983), p. 38

Property class: Void ratio
 Material: Smectite (Na)

Formation: -
 Location: -
 Condition 1: Water saturated.
 Condition 2: -
 Condition 3: -

Property/units: Void ratio (dimensionless)
 ranges from: 30.0
 to: 1.0
 as: Pressure
 ranges from: 100 psf (0.05 MPa) to:
 100,000 psf (4.7 MPa)

Reference: Olson and Mesri (1970)
 Source: ONWI-486 (1983), p. 38

13.1.3 Appendix A.3. HYDROLOGIC PROPERTIES

Property class: Hydraulic conductivity
 Material: Clay

Formation: Blue Clay
 Location: Italy

Condition 1:

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (m/s)
 ranges from: 10(-11) (1 x 10(-9) cm/s)
 to:
 as:

ranges from: to:

Reference: Two refs

Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Property class: Hydraulic conductivity
 Material: Clay

Formation: Boom Clay
 Location: Belgium

Condition 1:

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (m/s)
 ranges from: 10(-10) (1 x 10(-8) cm/s)
 to: 10(-12) (1 x 10(-10) cm/s)
 as:

ranges from: to:

Reference: Two refs

Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Property class: Hydraulic conductivity
 Material: Clay

Formation: Oxford Clay
 Location: England

Condition 1:

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (m/s)
 ranges from: 10(-12) (1 x 10(-10) cm/s)
 to:
 as:

ranges from: to:

Reference: Two refs

Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Property class: Hydraulic conductivity
 Material: Clay

Formation: Panther Creek Clay
 Location:

Condition 1: Confining force <100 lbs

Condition 2: Reference basalt ground water

Condition 3:

Property/units: Hydraulic conductivity (cm/s)
 ranges from: 7 x 10(-12)
 to: 2 x 10(-12)
 as: Density (g/cm(3))

ranges from: ca. 1.7 to: ca. 2.1

Reference:

Source: PNL-4452 UC-70 (1983), p. 14

Property class: Hydraulic conductivity
 Material: Clay

Formation: Porters Creek Clay
 Location: Louisiana

Condition 1: Smectite dominant; plus
 illite, kaolinite and
 chlorite

Condition 2: 5-50% quartz

Condition 3:

Property/units: Hydraulic conductivity (cm/s)
 ranges from: 10(-8) (est)
 to:
 as:

ranges from: to:

Reference:

Source: ORNL/Sub/84-64794/1 (1985), p. 175

Property class: Hydraulic conductivity
 Material: Clays and Shales

Formation:

Location:

Condition 1:

Condition 2:

Condition 3:

Property/units: Permeability (md)
 ranges from: 8 x 10(-4) (7.7 x 10(-10) cm/s)
 to: 2 x 10(-6) (1.9 x 10(-12) cm/s)

as:

ranges from: to:

Reference: Dickey (1972)

Source: Proc NEA Workshop OECD (1979b), p. 69

Property class: Hydraulic conductivity
 Material: Shale

Formation:

Location:

Condition 1: ADOPTED BASE VALUE

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: 1 x 10(-10) (1 x 10(-8) cm/s)
 to: 1 x 10(-12) (1 x 10(-10) cm/s)

as:

ranges from: to:

Reference:

Source: ORNL-6241/V1 (in preparation) p. 33

Property class: Hydraulic conductivity
 Material: Shale

Formation:

Location:

Condition 1: ADOPTED BASE VALUE

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (vertical) (m/s)
 ranges from: 1 x 10(-11) (1 x 10(-9) cm/s)
 to: 1 x 10(-13) (1 x 10(-11) cm/s)

as:

ranges from: to:

Reference:

Source: ORNL-6241/V1 (in preparation) p. 33

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location:
 Condition 1:
 Condition 2:
 Condition 3:
Property/units: Hydraulic conductivity (vertical) (m/s)
 ranges from: $1 \times 10(-12)$ ($1 \times 10(-10)$ cm/s)
 to:
 as:
 ranges from: to:
Reference: Loken, M. (personal communication) (1984)
Source: ORNL-6241/V2 (in preparation) p. 99

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location:
 Condition 1: Intact
 Condition 2: Range of properties
 Condition 3:
Property/units: Permeability (vertical) (factor of K horizontal)
 ranges from: $1/2Kh$
 to: $1/10Kh$
 as:
 ranges from: to:
Reference:
Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location: California
 Condition 1: Miocene
 Condition 2:
 Condition 3:
Property/units: Permeability (md)
 ranges from: $4 \times 10(-4)$ ($3.8 \times 10(-10)$ cm/s)
 to:
 as:
 ranges from: to:
Reference:
Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location: Gulf Coast
 Condition 1: Cenozoic
 Condition 2:
 Condition 3:
Property/units: Permeability (md)
 ranges from: $1 \times 10(-8)$ ($9.6 \times 10(-15)$ cm/s) (?)
 to: $2.5 \times 10(-9)$ ($2.4 \times 10(-15)$ cm/s) (?)
 as:
 ranges from: to:
Reference:
Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location: Maryland
 Condition 1: Triassic
 Condition 2: Newark-Gettysburg Basin
 Condition 3: Field test
Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: $0.0(?)$ (0.0 cm/s) (?)
 to: $1 \times 10(-9)$ ($1 \times 10(-7)$ cm/s)
 as:
 ranges from: to:
Reference: Gonzales (1984)
Source: ORNL-6241/V2 (in preparation) p. 43

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location: Michigan
 Condition 1: Devonian
 Condition 2: Core data
 Condition 3: $Kv << Kh$
Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: $1 \times 10(-11)$ ($1 \times 10(-9)$ cm/s)
 to: $2 \times 10(-8)$ ($2 \times 10(-6)$ cm/s)
 as:
 ranges from: to:
Reference: Gonzales (1984)
Source: ORNL-6241/V2 (in preparation) p. 42

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location: Pennsylvania
 Condition 1: Devonian
 Condition 2: Core data
 Condition 3:
Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: $3 \times 10(-11)$ ($3 \times 10(-9)$ cm/s)
 to:
 as:
 ranges from: to:
Reference: U. S. DOE (1981)
Source: ORNL-6241/V2 (in preparation) p. 42

Property class: Hydraulic conductivity
Material: Shale
 Formation:
 Location: Pennsylvania
 Condition 1: Devonian
 Condition 2: Field test
 Condition 3:
Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: $1 \times 10(-11)$ ($1 \times 10(-9)$ cm/s)
 to:
 as:
 ranges from: to:
Reference: U.S. DOE (1981)
Source: ORNL-6241/V2 (in preparation) p. 43

Property class: Hydraulic conductivity
 Material: Shale
 Formation:
 Location: South Carolina
 Condition 1: Triassic
 Condition 2: Dumbarton Basin
 Condition 3: Core data
 Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: $1 \times 10(-13)$ ($1 \times 10(-11)$ cm/s)
 to: $1 \times 10(-10)$ ($1 \times 10(-8)$ cm/s)
 as:
 ranges from: to:
 Reference: Gonzales (1984)
 Source: ORNL-6241/V2 (In preparation) p. 42

Property class: Hydraulic conductivity
 Material: Shale
 Formation:
 Location: South Carolina
 Condition 1: Triassic
 Condition 2: Dumbarton Basin
 Condition 3: Field test
 Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: $1 \times 10(-12)$ ($1 \times 10(-10)$ cm/s)
 to:
 as:
 ranges from: to:
 Reference: Gonzales (1984)
 Source: ORNL-6241/V2 (In preparation) p. 43

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Antrim Shale
 Location: Michigan
 Condition 1: Devonian
 Condition 2: Horizontal permeability higher than vertical
 Condition 3:
 Property/units: Permeability (md)
 ranges from: 0.001 ($1 \times 10(-9)$ cm/s)
 to: 2.0 ($1.9 \times 10(-6)$ cm/s)
 as:
 ranges from: to:
 Reference:
 Source: ORNL-5703 (1983), p. 109

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Antrim Shale
 Location: Michigan
 Condition 1: 50% quartz
 Condition 2: 20-35% illite and 5-15% kaolinite
 Condition 3: Bulk density = 2.2-2.8 g/cm³
 Property/units: Permeability (md)
 ranges from: 0.001 ($1 \times 10(-9)$ cm/s)
 to: 2.0 ($1.9 \times 10(-6)$ cm/s)
 as:
 ranges from: to:
 Reference: Young (1978)
 Source: ORNL/Sub/84-64794/1 (1985), p. 98

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Arnheim and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3:
 Property/units: Permeability (ft/yr) (hydraulic conductivity)
 ranges from: $10(-3)$ ($9.7 \times 10(-10)$ cm/s)
 to: $10(-4)$ ($9.7 \times 10(-11)$ cm/s)
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3:
 Property/units: Permeability (horizontal) (ft/yr) (hydraulic conductivity)
 ranges from: 0.1 ($9.7 \times 10(-8)$ cm/s)
 to:
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3:
 Property/units: Permeability (vertical) (ft/yr) (hydraulic conductivity)
 ranges from: 0.05 ($5 \times 10(-8)$ cm/s)
 to:
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Conasauga Shale
 Location: Tennessee
 Condition 1: Cambrian
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity (cm/s)
 ranges from: $6 \times 10(-10)$
 to: $3 \times 10(-11)$
 as: Depth (m)
 ranges from: 50 to: 850
 Reference: Delaguna (1968)
 Source: ORNL-6241/V2 (In preparation) p. 220

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Conasauga Shale
 Location: Tennessee
 Condition 1: Cambrian
 Condition 2: Core data
 Condition 3:
 Property/units: Hydraulic conductivity
 (horizontal) (m/s)
 ranges from: $3 \times 10(-13)$ ($3 \times 10(-11)$
 cm/s)
 to: $2 \times 10(-12)$ ($2 \times 10(-10)$
 cm/s)
 as:
 ranges from: to:
 Reference: DeLaguna (1968)
 Source: ORNL-6241/V2 (in preparation) p. 42

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Maquoketa Shale
 Location: Illinois
 Condition 1: Ordovician
 Condition 2: Field test
 Condition 3:
 Property/units: Hydraulic conductivity
 (horizontal) (m/s)
 ranges from: $2 \times 10(-11)$ ($2 \times 10(-9)$
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Gonzales (1984)
 Source: ORNL-6241/V2 (in preparation) p. 42

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Maquoketa Shale
 Location: Illinois Basin
 Condition 1: Ordovician
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity (cm/s)
 ranges from: $10(-9)$
 to:
 as:
 ranges from: to:
 Reference: Gonzales and Johnson (1984)
 Source: ORNL-6241/V2 (in preparation) p. 220

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Muddy Shale (a)
 Location:
 Condition 1: Cretaceous
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: $5 \times 10(-2)$ ($4.8 \times 10(-8)$
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Muddy Shale (b)
 Location: Colorado
 Condition 1: Depth: 4,900 ft
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: <0.05 ($<4.8 \times 10(-8)$ cm/s)
 to:
 as:
 ranges from: to:
 Reference: Handin et al (1963)
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Pierre Shale
 Location:
 Condition 1: Intact
 Condition 2:
 Condition 3:
 Property/units: Permeability (horizontal)
 (ft/yr) (hydraulic conductivity)
 ranges from: 0.01 ($9.7 \times 10(-9)$ cm/s)
 to:
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Pierre Shale
 Location:
 Condition 1: Intact
 Condition 2:
 Condition 3:
 Property/units: Permeability (vertical)
 (ft/yr) (hydraulic conductivity)
 ranges from: 0.005 ($5 \times 10(-9)$ cm/s)
 to:
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Hydraulic conductivity
 Material: Shale
 Formation: Pierre Shale
 Location: South Dakota
 Condition 1: Field test
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity
 (horizontal) (m/s)
 ranges from: $1 \times 10(-12)$ ($1 \times 10(-10)$
 cm/s)
 to: $1 \times 10(-11)$ ($1 \times 10(-9)$
 cm/s)
 as:
 ranges from: to:
 Reference: Brace (1980)
 Source: ORNL-6241/V2 (in preparation) p. 43

Property class: Hydraulic conductivity
 Material: Shale (a)
 Formation:
 Location:
 Condition 1:
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity
 (horizontal) (m/s)
 ranges from: $1 \times 10(-11)$ $(1 \times 10(-9)$
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Loken, M. (personal communication)
 (1984)
 Source: ORNL-6241/V2 (in preparation) p. 99

Property class: Hydraulic conductivity
 Material: Shale (a)
 Formation:
 Location:
 Condition 1: "Typical" illitic shale
 Condition 2: Intact
 Condition 3:
 Property/units: Permeability (ft/yr)
 (hydraulic conductivity)
 ranges from: 0.1 $(9.7 \times 10(-8)$ cm/s)
 to: 0.05 $(4.8 \times 10(-8)$ cm/s)
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Hydraulic conductivity
 Material: Shale (a)
 Formation: Pierre Shale
 Location:
 Condition 1: Cretaceous
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: $1.1 \times 10(-4)$ $(1.1 \times 10(-10)$
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shale (b)
 Formation:
 Location:
 Condition 1: Core data
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity
 (horizontal) (m/s)
 ranges from: $1 \times 10(-16)$ $(1 \times 10(-14)$
 cm/s)
 to: $1 \times 10(-11)$ $(1 \times 10(-9)$
 cm/s)
 as:
 ranges from: to:
 Reference: Brace (1980)
 Source: ORNL-6241/V2 (in preparation) p. 42

Property class: Hydraulic conductivity
 Material: Shale (b)
 Formation:
 Location:
 Condition 1:
 Condition 2:
 Condition 3:
 Property/units: Permeability (microdarcies)
 ranges from: 100 $(1 \times 10(-7)$ cm/s)
 to: 0.01 $(1 \times 10(-9)$ cm/s)
 as: Depth (m)
 ranges from: 0 to: 6,000
 Reference: Several refs
 Source: ORNL-6241/V2 (in preparation) p. 199

Property class: Hydraulic conductivity
 Material: Shale (b)
 Formation: Pierre Shale
 Location: Great Plains
 Condition 1: Mixed-layer illite-smectite dominant
 Condition 2: Plus smectite, illite,
 kaolinite and chlorite
 Condition 3: Up to 25% quartz
 Property/units: Permeability (cm/s)
 (hydraulic conductivity)
 ranges from: $1 \times 10(-6)$
 to: $1 \times 10(-10)$
 as:
 ranges from: to:
 Reference: Abel and Gentry (1975)
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Hydraulic conductivity
 Material: Shale (c)
 Formation:
 Location:
 Condition 1: Core data
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity
 (horizontal) (m/s)
 ranges from: $1 \times 10(-11)$ $(1 \times 10(-9)$
 cm/s)
 to: $7 \times 10(-9)$ $(7 \times 10(-7)$
 cm/s)
 as:
 ranges from: to:
 Reference: Pandey (1974)
 Source: ORNL-6241/V2 (in preparation) p. 42

Property class: Hydraulic conductivity
 Material: Shale (d)
 Formation:
 Location:
 Condition 1: Generic properties
 Condition 2: Note: $K(\text{vertical}) = 1/2$ to
 $1/10 K(\text{horizontal})$
 Condition 3:
 Property/units: Hydraulic conductivity
 (horizontal) (m/s)
 ranges from: $1 \times 10(-11)$ $(1 \times 10(-9)$
 cm/s)
 to: $1 \times 10(-6)$ $(1 \times 10(-4)$
 cm/s)
 as:
 ranges from: to:
 Reference: D'Appolonia (1980)
 Source: ORNL-6241/V2 (in preparation) p. 43

Property class: Hydraulic conductivity
 Material: Shale (e)
 Formation:
 Location:
 Condition 1: Intact
 Condition 2: Range of properties
 Condition 3:
 Property/units: Permeability (horizontal)
 (ft/yr) (hydraulic conductivity)
 ranges from: 1×10^{-4} (9.7×10^{-11}
 cm/s)
 to: 1×10^{-3} (9.7×10^{-4}
 cm/s)
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location:
 Condition 1: Paleozoic
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: 8×10^{-4} (7.7×10^{-10}
 cm/s)
 to: 2×10^{-6} (1.9×10^{-12}
 cm/s)
 as:
 ranges from: to:
 Reference:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: East Coast
 Condition 1: Triassic basins
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity (cm/s)
 ranges from: 10^{-7}
 to: 10^{-11}
 as:
 ranges from: to:
 Reference: Gonzales and Johnson (1984)
 Source: ORNL-6241/V2 (In preparation) p. 220

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: Illinois
 Condition 1: Paleozoic
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: 2×10^{-6} (1.9×10^{-12}
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: Michigan and Appalachian
 Basins
 Condition 1: Devonian
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity (cm/s)
 ranges from: 10^{-6}
 to: 10^{-9}
 as:
 ranges from: to:
 Reference: Gonzales and Johnson (1984)
 Source: ORNL-6241/V2 (In preparation) p. 220

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: Montana
 Condition 1: Paleozoic
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: 6×10^{-4} (5.8×10^{-10}
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: New Mexico
 Condition 1: Paleozoic
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: 2×10^{-6} (1.9×10^{-12}
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: Oklahoma
 Condition 1: Paleozoic
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: 8×10^{-4} (7.7×10^{-10}
 cm/s)
 to:
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: Texas
 Condition 1: Paleozoic
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: $3 \times 10(-4)$ ($2.9 \times 10(-10)$ cm/s)
 to: $7 \times 10(-6)$ ($6.7 \times 10(-12)$ cm/s)
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shales
 Formation:
 Location: Utah
 Condition 1: Paleozoic
 Condition 2:
 Condition 3:
 Property/units: Permeability (md)
 ranges from: $7 \times 10(-6)$ ($6.7 \times 10(-12)$ cm/s)
 to:
 as:
 ranges from: to:
 Reference: Two refs
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Property class: Hydraulic conductivity
 Material: Shales
 Formation: Pierre, Bearpaw and Claggett Shales
 Location: Northern Great Plains
 Condition 1: Cretaceous
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity (cm/s)
 ranges from: $10(-6)$
 to: $10(-10)$
 as:
 ranges from: to:
 Reference: Abel and Gentry (1975)
 Source: ORNL-6241/V2 (in preparation) p. 220

Property class: Hydraulic conductivity
 Material: Shales (c)
 Formation:
 Location:
 Condition 1:
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity (cm/s)
 ranges from: $10(-8)$
 to: $10(-11)$
 as:
 ranges from: to:
 Reference:
 Source: ORNL-6241/V2 (in preparation) p. 218

Property class: Hydraulic conductivity
 Material: Shales (d)
 Formation:
 Location:
 Condition 1: In situ
 Condition 2:
 Condition 3:
 Property/units: Hydraulic conductivity (cm/s)
 ranges from: $10(-9)$
 to: $10(-11)$
 as:
 ranges from: to:
 Reference: Brace (1980)
 Source: ORNL-6241/V2 (in preparation) p. 219

Property class: Hydraulic conductivity
 Material: Shales (e)
 Formation:
 Location:
 Condition 1:
 Condition 2:
 Condition 3:
 Property/units: Permeability (m²)
 ranges from: $10(-17)$ ($9.7 \times 10(-9)$ cm/s)
 to: $10(-21)$ ($9.7 \times 10(-13)$ cm/s)
 as: Depth (m)
 ranges from: 0 to: 6,000
 Reference: Several refs
 Source: ORNL-6241/V2 (in preparation) p. 199

Property class: Hydraulic conductivity
 Material: Shales (f)
 Formation:
 Location: Various
 Condition 1: Various formations, depths, etc.
 Condition 2: Represents many tests
 Condition 3:
 Property/units: Permeability (ft/yr)
 (hydraulic conductivity)
 ranges from: $1.0 \times 10(-4)$ ($9.7 \times 10(-11)$ cm/s)
 to: $1.1 \times 10(3)$ ($1.1 \times 10(-4)$ cm/s)
 as:
 ranges from: to:
 Reference: Three refs
 Source: Y/OWI/TM36/6 (1978), p. A-16

Property class: Hydraulic conductivity
 Material: Siltstone/Mudstone
 Formation:
 Location: South Carolina
 Condition 1: Triassic
 Condition 2: Field test
 Condition 3:
 Property/units: Hydraulic conductivity (horizontal) (m/s)
 ranges from: $1 \times 10(-13)$ ($1 \times 10(-11)$ cm/s)
 to: $5 \times 10(-10)$ ($5 \times 10(-8)$ cm/s)
 as:
 ranges from: to:
 Reference: Brace (1980)
 Source: ORNL-6241/V2 (in preparation) p. 43

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Ca)

- Formation:
- Location:
- Condition 1: Density 2.09 and 2.11 g/cm(3)
- Condition 2: Head 20.7 and 15.4 MPa
- Condition 3: Hydraulic gradient 2.13 x 10(5) and 1.59 x 10(5)

Property/units: Hydraulic conductivity (cm/s) ranges from: $1.3 \times 10(-12)$ and $1.6 \times 10(-12)$

- to:
- as:

ranges from: to:

Reference:

Source: ONWI-312 (1981), p. 33

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Ca)

- Formation:
- Location:
- Condition 1: 80-90% quartz powder
- Condition 2: Water content 5-15%
- Condition 3: Field compacted

Property/units: Permeability (m/s) (hydraulic conductivity)

ranges from: $1 \times 10(-9)$ ($1 \times 10(-7)$ cm/s)

- to:
- as:

ranges from: to:

Reference: Jacobsson and Pusch (1977)

Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Ca) and (Na)

- Formation:
- Location:
- Condition 1: Density (dry) (bulk) (g/cm(3)) =
- Condition 2: Load (MPa) = 0.1
- Condition 3:

Property/units: Permeability (m(2))

ranges from: $1 \times 10(-16)$ ($9.7 \times 10(-8)$ cm/s)

- to:
- as:

ranges from: to:

Reference: Grim (1962)

Source: NUREG/CP-052 (1983), p. 209

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na)

- Formation:
- Location:
- Condition 1: 75% sand
- Condition 2: Density (initial) 2.1 g/cm(3)
- Condition 3:

Property/units: Hydraulic conductivity (cm/s)

ranges from: $2.7 \times 10(-9)$ to: $0.7 \times 10(-9)$

- as: Time (hrs)

ranges from: 10 to: 900

Reference:

Source: ONWI-312 (1981), p. 34

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na)

- Formation:
- Location: Wyoming
- Condition 1: MX-80
- Condition 2: Compacted at 50 MPa; density = $2.0-2.3 \text{ t/m}^3$
- Condition 3: 10% water by weight

Property/units: Hydraulic conductivity (cm/s) ranges from: Not stated to: $10(-9)$

- as: Density (t/m^3)

ranges from: 2.0 - 2.3 to: 1.0

Reference: Several refs

Source: ONWI-486 (1983), p. 61

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na) (a)

- Formation:
- Location:
- Condition 1: Three tests
- Condition 2:
- Condition 3:

Property/units: Hydraulic conductivity (cm/s x $10(12)$)

ranges from: <1 ($<1 \times 10(-12)$ cm/s) to: ca. 8 ($ca. 8 \times 10(-12)$ cm/s)

- as: Hydraulic pressure gradient ($\text{psi/ft} \times 10(-8)$)

ranges from: 1.5 to: 7

Reference: Kharaka and Smalley (1976)

Source: ONWI-312 (1981), p. 11

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na) (b)

- Formation:
- Location:
- Condition 1: Highly compacted
- Condition 2:
- Condition 3:

Property/units: Hydraulic conductivity (cm/s) ranges from: ca. $1 \times 10(-13)$ to:

- as:

ranges from: to:

Reference: Kharaka and Smalley (1976)

Source: ONWI-312 (1981), p. 10

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na) (c)

- Formation:
- Location:
- Condition 1: 50% sand; density 2.12 and 2.09 g/cm(3)
- Condition 2: Head 15.5 and 16.7 MPa
- Condition 3: Hydraulic gradient 1.62 x 10(5) and $1.73 \times 10(5)$

Property/units: Hydraulic conductivity (cm/s) ranges from: $4.6 \times 10(-12)$ and $6.4 \times 10(-12)$

- to:
- as:

ranges from: to:

Reference:

Source: ONWI-312 (1981), p. 33

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (d)

Formation:

Location:

Condition 1: 75% sand; density 2.10
g/cm(3)

Condition 2: Head 3.4 MPa

Condition 3: Hydraulic gradient 1.19 x
10(4)

Property/units: Hydraulic conductivity (cm/s)
ranges from: 6.6 x 10(-10)

to:

as:

ranges from: to:

Reference:

Source: ONWI-312 (1981), p. 33

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (e)

Formation:

Location:

Condition 1: Density 2.13 g/cm(3)

Condition 2: Head 14.6 MPa

Condition 3: Hydraulic gradient 1.56 x
10(5)

Property/units: Hydraulic conductivity (cm/s)
ranges from: 5.6 x 10(-13)

to:

as:

ranges from: to:

Reference:

Source: ONWI-312 (1981), p. 33

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (f)

Formation:

Location:

Condition 1: CS-50

Condition 2: Confining force <100 lbs

Condition 3: Reference basalt ground water

Property/units: Hydraulic conductivity (cm/s)
ranges from: 6 x 10(-12)

to: 6 x 10(-13)

as: Density (g/cm(3))

ranges from: ca. 1.7 to: ca. 2.2

Reference:

Source: PNL-4452 UC-70 (1983), p. 13

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (g)

Formation:

Location:

Condition 1: Various radiation treatments

Condition 2: Various heat treatments (to
300 deg C)

Condition 3: Density (g/cm(3)) from
2.07-2.22

Property/units: Hydraulic conductivity (cm/s)
ranges from: 1.2 x 10(-12)

to: 8.3 x 10(-13)

as:

ranges from: to:

Reference:

Source: PNL-4452 UC-70 (1983), p. 27

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (h)

Formation:

Location:

Condition 1: Plus quartz

Condition 2: Hydraulic gradient ca. 100

Condition 3:

Property/units: Permeability (cm/s)
(hydraulic conductivity)

ranges from: 1 x 10(-11)

to:

as: Bentonite content (%)

ranges from: 20 to:

Reference: Pusch (1979)

Source: ONWI-312 (1981), p. 10

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (i)

Formation:

Location:

Condition 1: Plus quartz

Condition 2: Hydraulic gradient ca. 100

Condition 3:

Property/units: Permeability (cm/s)
(hydraulic conductivity)

ranges from: 3 x 10(-8)

to: 1.5 x 10(-9)

as: Bentonite content (%)

ranges from: 4 to: 8

Reference: Pusch (1979)

Source: ONWI-312 (1981), p. 10

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (j)

Formation:

Location:

Condition 1: MX-80

Condition 2:

Condition 3:

Property/units: Permeability (m/s) (hydraulic
conductivity)

ranges from: 5 x 10(-15) (5 x 10(-13)

cm/s)

to: 1 x 10(-11) (1 x 10(-9)

cm/s)

as: Density (t/m(3))

ranges from: ca. 2.5 to: ca. 1.2

Reference:

Source: KBS TEKNISK RAPPORT 74 (1978), p. 8

Property class: Hydraulic conductivity
(minerals)

Material: Bentonite (Na) (k)

Formation:

Location:

Condition 1: 67% quartz powder

Condition 2:

Condition 3:

Property/units: Permeability (m/s) (hydraulic
conductivity)

ranges from: ca. 1 x 10(-11) (ca. 1 x

10(-9) cm/s)

to:

as:

ranges from: to:

Reference: Jacobsson and Pusch (1977)

Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na) (l)

Formation:

Location:

Condition 1: 80-90% quartz powder

Condition 2: Water content 5-15%

Condition 3: Field compacted

Property/units: Permeability (m/s) (hydraulic conductivity)

ranges from: ca. 3×10^{-11} (ca. 3×10^{-9} cm/s)

to:

as:

ranges from: to:

Reference: Jacobsson and Pusch (1977)

Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na) (m)

Formation:

Location:

Condition 1: Bentonite >10%

Condition 2: Bulk density >1.6 t/m(3)

Condition 3:

Property/units: Permeability (m/s) (hydraulic conductivity)

ranges from: 1×10^{-10} (1×10^{-8} cm/s) (maximum)

to:

as:

ranges from: to:

Reference:

Source: KBS TEKNISK RAPPORT 9 (1977), p. 5

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na) and (Ca)

Formation:

Location: Various

Condition 1: Sand/silt/gravel mixtures

Condition 2: Density = 1.8 to 2.2 g/cm(3)

Condition 3:

Property/units: Hydraulic conductivity (cm/s)

ranges from: 10^{-4}

to: 10^{-12}

as: % Bentonite

ranges from: <10 to: 100

Reference: Several refs

Source: ONWI-486 (1983), p. 36

Property class: Hydraulic conductivity (minerals)

Material: Bentonite (Na) and Sand

Formation:

Location:

Condition 1: Density (g/cm(3)) = 2.0 - 2.2

Condition 2: Temperature = 25 deg C

Condition 3: Reference basalt ground water

Property/units: Hydraulic conductivity (cm/s)

ranges from: ca. 10^{-9}

to: ca. 10^{-12}

as: Bentonite content (%)

ranges from: 25 to: 75

Reference:

Source: PNL-4452 UC-70 (1983), p. 16

Property class: Hydraulic conductivity (minerals)

Material: Bentonite and Sand

Formation:

Location:

Condition 1: Various mixtures of bentonite and sand

Condition 2: Initial density (dry) = 2.1 Mg/m(3)

Condition 3:

Property/units: Hydraulic conductivity (m/s)

ranges from: ca. 10^{-6} (ca. 1×10^{-4} cm/s)

to: ca. 10^{-14} (ca. 1×10^{-12} cm/s)

as: Percent bentonite (%)

ranges from: ca. 5 to: 100

Reference:

Source: AECL-7812 (1983), p. 29

Property class: Hydraulic conductivity (minerals)

Material: Bentonite and Sand (a)

Formation:

Location: Oregon

Condition 1: 10% bentonite

Condition 2: Saturation time (days) = 37

Condition 3: Hydraulic gradient = 4

Property/units: Permeability (cm/s) (hydraulic conductivity)

ranges from: 9.5×10^{-8}

to:

as:

ranges from: to:

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 7

Property class: Hydraulic conductivity (minerals)

Material: Bentonite and Sand (b)

Formation:

Location: Oregon

Condition 1: 50% bentonite

Condition 2: Saturation time (days) = 62 (still saturating)

Condition 3: Hydraulic gradient = 4

Property/units: Permeability (cm/s) (hydraulic conductivity)

ranges from: < 9.5×10^{-8}

to:

as:

ranges from: to:

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 7

Property class: Hydraulic conductivity (minerals)

Material: Bentonite and Sand (c)

Formation:

Location: Wyoming

Condition 1: 10% bentonite

Condition 2: Saturation time (days) = 42 (still saturating)

Condition 3: Hydraulic gradient = 4

Property/units: Permeability (cm/s) (hydraulic conductivity)

ranges from: < 9.5×10^{-8}

to:

as:

ranges from: to:

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 7

Property class: Hydraulic conductivity (minerals)

Material: Bentonite and Sand (d)

Formation:
Location: Wyoming

Condition 1: 50% bentonite
Condition 2: Saturation time (days) = 53
(still saturating)

Condition 3: Hydraulic gradient = 4

Property/units: Permeability (cm/s)
(hydraulic conductivity)
ranges from: $9.5 \times 10(-8)$
to:
as:
ranges from: to:
Reference: Taylor et al (1980)
Source: RHO-BWI-SA-80 (1981), p. 7

Property class: Hydraulic conductivity (minerals)

Material: Bentonite and Sand (e)

Formation:
Location: Wyoming

Condition 1: 75% sand
Condition 2: 20 - 80 mesh sand
Condition 3: Density (dry) (bulk)
(g/cm³) = 1.72

Property/units: Permeability (m(2))
ranges from: $3 \times 10(-18)$ (2.9 $\times 10(-9)$ cm/s)
to:
as:
ranges from: to:
Reference: Grim (1962)
Source: NUREG/CP-0052 (1983), p. 220

Property class: Hydraulic conductivity (minerals)

Material: Bentonite and Sand (f)

Formation:
Location: Wyoming

Condition 1: 75% sand
Condition 2: 80 - 140 mesh sand
Condition 3: Density (dry) (bulk)
(g/cm³) = 1.59

Property/units: Permeability (m(2))
ranges from: $8 \times 10(-18)$ (7.8 $\times 10(-9)$ cm/s)
to:
as:
ranges from: to:
Reference:
Source: NUREG/CP-0052 (1983), p. 220

Property class: Hydraulic conductivity (minerals)

Material: Clay and Sand

Formation:
Location: Hanford

Condition 1: 50% Ringold clay
Condition 2: Saturation time (days) = 38
(still saturating)

Condition 3: Hydraulic gradient = 4

Property/units: Permeability (cm/s)
(hydraulic conductivity)
ranges from: $9.5 \times 10(-8)$
to:
as:
ranges from: to:
Reference: Taylor et al (1980)
Source: RHO-BWI-SA-80 (1981), p. 7

Property class: Hydraulic conductivity (minerals)

Material: Illite (Ca)

Formation:
Location:

Condition 1:
Condition 2:
Condition 3:

Property/units: Hydraulic conductivity (cm/s)
ranges from: 10(-10)
to: 10(-6)
as: Void ratio
ranges from: 0.7 to: 6

Reference: Mesri and Olson (1971)
Source: ONWI-486 (1983), p. 35

Property class: Hydraulic conductivity (minerals)

Material: Illite (Na)

Formation:
Location:

Condition 1:
Condition 2:
Condition 3:

Property/units: Hydraulic conductivity (cm/s)
ranges from: 10(-10)
to: 10(-7)
as: Void ratio
ranges from: 0.7 to: 7

Reference: Mesri and Olson (1971)
Source: ONWI-486 (1983), p. 35

Property class: Hydraulic conductivity (minerals)

Material: Kaolinite (a)

Formation:
Location:

Condition 1: Density (dry) (bulk)
(g/cm³) =
Condition 2: Load (MPa) = 0.1
Condition 3:

Property/units: Permeability (m(2))
ranges from: $1 \times 10(-16)$ (9.7 $\times 10(-8)$ cm/s)
to:
as:
ranges from: to:
Reference: Grim (1962)
Source: NUREG/CP-0052 (1983), p. 209

Property class: Hydraulic conductivity (minerals)

Material: Kaolinite (b)

Formation:
Location:

Condition 1: Density (dry) (bulk)
(g/cm³) =
Condition 2: Load (MPa) = 6.4
Condition 3:

Property/units: Permeability (m(2))
ranges from: $5 \times 10(-17)$ (4.9 $\times 10(-8)$ cm/s)
to:
as:
ranges from: to:
Reference: Grim (1962)
Source: NUREG/CP-0052 (1983), p. 209

Property class: Hydraulic conductivity (minerals)

Material: Kaolinite (Ca)

Formation:

Location:

Condition 1:

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (cm/s)
ranges from: 10(-8)

to: 10(-5)

as: Void ratio

ranges from: 0.7 to: 2

Reference: Mesri and Olson (1971)

Source: ONWI-486 (1983), p. 35

Property class: Hydraulic conductivity (minerals)

Material: Kaolinite (Na)

Formation:

Location:

Condition 1:

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (cm/s)
ranges from: 10(-8)

to: 10(-5)

as: Void ratio

ranges from: 0.7 to: 2

Reference: Mesri and Olson (1971)

Source: ONWI-486 (1983), p. 35

Property class: Hydraulic conductivity (minerals)

Material: Kaolinite and Sand

Formation:

Location:

Condition 1: Density (dry) (bulk)
(g/cm³) (not stated)

Condition 2: Load (MPa) = 6.4

Condition 3: 30% kaolinite

Property/units: Permeability (m(2))
ranges from: 2 x 10(-16) (1.9 x 10(-7)

cm/s)

to:

as:

ranges from: to:

Reference: Grim (1962)

Source: NUREG/CP-0052 (1983), p. 209

Property class: Hydraulic conductivity (minerals)

Material: Silty Clay

Formation:

Location:

Condition 1: Kneading compaction

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (cm/s)
ranges from: 5 x 10(-6)

to: ca. 2 x 10(-8)

as: Molding water content (wt. %)

ranges from: 13 to: 25

Reference: Mitchell (1976)

Source: ONWI-486 (1983), p. 39

Property class: Hydraulic conductivity (minerals)

Material: Silty Clay

Formation:

Location:

Condition 1: Static compaction

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (cm/s)
ranges from: 5 x 10(-6)

to: 10(-7)

as: Molding water content (wt. %)

ranges from: 13 to: 23

Reference: Mitchell (1976)

Source: ONWI-486 (1983), p. 39

Property class: Hydraulic conductivity (minerals)

Material: Smectite (Ca) (a)

Formation:

Location:

Condition 1:

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (cm/s)
ranges from: 10(-11)

to: 10(-6)

as: Void ratio

ranges from: 1 to: 6

Reference: Mesri and Olson (1971)

Source: ONWI-486 (1983), p. 35

Property class: Hydraulic conductivity (minerals)

Material: Smectite (Ca) (b)

Formation:

Location:

Condition 1: Density (dry) (bulk)
(g/cm³) (not stated)

Condition 2: Load (MPa) = 6.4

Condition 3:

Property/units: Permeability (m(2))
ranges from: 3 x 10(-18) (2.9 x 10(-9)

cm/s)

to:

as:

ranges from: to:

Reference: Grim (1962)

Source: NUREG/CP-0052 (1983), p. 209

Property class: Hydraulic conductivity (minerals)

Material: Smectite (Ca) and Sand

Formation:

Location:

Condition 1: Density (dry) (bulk)
(g/cm³) (not stated)

Condition 2: Load (MPa) = 6.4

Condition 3: 30% smectite

Property/units: Permeability (m(2))
ranges from: 4 x 10(-17) (3.9 x 10(-8)

cm/s)

to:

as:

ranges from: to:

Reference: Grim (1962)

Source: NUREG/CP-0052 (1983), p. 209

Property class: Hydraulic conductivity (minerals)

Material: Smectite (Na) (a)

Formation:

Location:

Condition 1:

Condition 2:

Condition 3:

Property/units: Hydraulic conductivity (cm/s)

ranges from: 10(-11) to: 10(-7) as: Void ratio ranges from: 1 to: 30

Reference: Mesri and Olson (1971)

Source: ONWI-486 (1983), p. 35

Property class: Hydraulic conductivity (minerals)

Material: Smectite (Na) and Sand

Formation:

Location:

Condition 1: Density (dry) (bulk) (g/cm³) (not stated)

Condition 2: Load (MPa) = 6.4

Condition 3: 30% smectite

Property/units: Permeability (m²)

ranges from: 5 x 10(-19) to: cm/s as: ranges from: to:

Reference: Grim (1962)

Source: NUREG/CP-0052 (1983), p. 209

Property class: Hydraulic conductivity (minerals)

Material: Volclay saline seal and Sand

Formation:

Location:

Condition 1: 50% sand

Condition 2: Density 2.22 g/cm³

Condition 3: Various heads and hydraulic gradients

Property/units: Hydraulic conductivity (cm/s)

ranges from: 2.9 x 10(-12) to: 4.1 x 10(-12) as: ranges from: to:

Reference:

Source: ONWI-312 (1981), p. 33

Property class: Miscellaneous

Material: Shale

Formation:

Location:

Condition 1: Pre-emplacement travel

Condition 2: 100,000 years

Condition 3:

Property/units: Groundwater travel distance (m)

ranges from: 0.3 to: 40 as: ranges from: to:

Reference:

Source: ORNL-6241/V1 (in preparation) p. 36

Property class: Miscellaneous

Material: Shale

Formation:

Location:

Condition 1: Preclosure mined openings

Condition 2:

Condition 3:

Property/units: Inflow (ml/min per m)

ranges from: 10 to: 5 x 10(-1) as: Time (days) ranges from: 0.1 to: 5,000

Reference:

Source: ORNL-6241/V1 (in preparation) p. 38

Property class: Miscellaneous

Material: Shale

Formation:

Location:

Condition 1:

Condition 2:

Condition 3:

Property/units: Inflow (ml/min per m)

ranges from: 10 to: <1 as: Time (days) ranges from: 0.1 to: 5,000

Reference:

Source: ORNL-6241/V2 (in preparation) p. 106

Property class: Miscellaneous

Material: Shale

Formation:

Location:

Condition 1:

Condition 2:

Condition 3:

Property/units: Specific storage (l/m)

ranges from: 1 x 10(-6) to: as: ranges from: to:

Reference: Loken, M. (personal communication) (1984)

Source: ORNL-6241/V2 (in preparation) p. 99

Property class: Miscellaneous

Material: Shale

Formation:

Location:

Condition 1: Computed value

Condition 2:

Condition 3:

Property/units: Specific storage (l/m)

ranges from: 4.3 x 10(-7) to: 2.8 x 10(-6) as: ranges from: to:

Reference:

Source: ORNL-6241/V2 (in preparation) p. 57

Property class: Miscellaneous
Material: Shale
Formation:
Location:
Condition 1: ADOPTED BASE VALUE
Condition 2:
Condition 3:
Property/units: Specific storage ($m(-1)$) (?)
ranges from: $5 \times 10(-6)$
to: $5 \times 10(-7)$
as:
ranges from: to:
Reference:
Source: ORNL-6241/V1 (in preparation) p. 33

Property class: Miscellaneous
Material: Shale
Formation:
Location:
Condition 1: Pre-emplacement travel
Condition 2: 10 km distance
Condition 3:
Property/units: Travel time (years)
ranges from: >100,000
to: >100,000
as:
ranges from: to:
Reference:
Source: ORNL-6241/V1 (in preparation) p. 36

13.1.4 Appendix A.4. MECHANICAL PROPERTIES

Property class: Bulk modulus
 Material: Argillite
 Formation: Eleana Argillite
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Bulk modulus (confined) (GPa)
 ranges from: 14.0 (1.4 x 10(4) MPa)
 to: -
 as: -
 ranges from: - to: -

Reference: Y/OWI/TM-36/6 (1978)
 Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Bulk modulus
 Material: Shale
 Formation: -
 Location: -
 Condition 1: Typical illitic shale
 Condition 2: Intact
 Condition 3: -
 Property/units: Bulk modulus (psi)
 ranges from: 7.6 x 10(5) (5.2 x 10(3) MPa)
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Bulk modulus
 Material: Shale
 Formation: Arnhem and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3: -
 Property/units: Bulk modulus (psi)
 ranges from: 6.3 x 10(5) (4.3 x 10(3) MPa)
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Bulk modulus
 Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3: -
 Property/units: Bulk modulus (psi)
 ranges from: 1.1 x 10(5) (7.6 x 10(2) MPa)
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Bulk modulus
 Material: Shale
 Formation: Pierre Shale
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
 Property/units: Bulk modulus (psi)
 ranges from: 77.8 x 10(3) (5.4 x 10(2) MPa)
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Bulk modulus
 Material: Shales
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Bulk modulus (Pa x 10(10))
 ranges from: ca. 50 (ca. 5 x 10(5) MPa)
 to: ca. 200 (ca. 2 x 10(6) MPa)
 as: Depth (m)
 ranges from: 0 to: 6,000

Reference: Three refs
 Source: ORNL-6241/V2 (in preparation) p. 199

Property class: Cohesion
 Material: Argillite
 Formation: Eleana Argillite
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Cohesion (unconfined) (MPa)
 ranges from: 8 x 10(-1)
 to: -
 as: -
 ranges from: - to: -

Reference: Y/OWI/TM-36/6 (1978)
 Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Cohesion
 Material: Clay
 Formation: Blue Clay
 Location: Italy
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Cohesion (MPa)
 ranges from: 1 x 10(-1)
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Cohesion

Material: Clay

Formation: Boom Clay

Location: Belgium

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Cohesion (MPa)

ranges from: $1 \times 10(-1)$

to: 1

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Cohesion

Material: Shale

Formation: Arnhem and Waynesville Fms

Location: Ohio

Condition 1: Ordovician

Condition 2: Intact

Condition 3: -

Property/units: Cohesion (psi)

ranges from: 5,900 ($4.1 \times 10(1)$ MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Cohesion

Material: Shale

Formation: Chagrin Shale

Location: Ohio

Condition 1: Devonian

Condition 2: Intact

Condition 3: -

Property/units: Cohesion (psi)

ranges from: 14 ($1 \times 10(-1)$ MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Cohesion

Material: Shale (a)

Formation: -

Location: -

Condition 1: Intact

Condition 2: Range of properties

Condition 3: -

Property/units: Cohesion (psi)

ranges from: 0 (0 MPa)

to: 4,250 ($3 \times 10(1)$ MPa)

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Cohesion

Material: Shale (b)

Formation: -

Location: -

Condition 1: Typical illitic shale

Condition 2: Intact

Condition 3: -

Property/units: Cohesion (psi)

ranges from: $6 \times 10(3)$ ($4.1 \times 10(1)$ MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Cohesion

Material: Shale (c)

Formation: Pierre Shale

Location: -

Condition 1: Intact

Condition 2: -

Condition 3: -

Property/units: Cohesion (psi)

ranges from: 206 (1.4 MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Cohesion

Material: Shale (d)

Formation: Pierre Shale

Location: Great Plains

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Cohesion (psi)

ranges from: 2 ($1.4 \times 10(-2)$ MPa)to: 30 ($2.1 \times 10(-1)$ MPa)

as: -

ranges from: - to: -

Reference: Abel and Gentry (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Compressive strength

Material: Argillite

Formation: Eleana Argillite

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Compressive strength

(unconfined) (MPa)

ranges from: 4.75

to: -

as: -

ranges from: - to: -

Reference: Y/OWI/TM-36/6 (1978)

Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Compressive strength
Material: Bentonite (Na) (a)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (unconfined) (psi)
 ranges from: 55.5 (3.8 x 10(-1) MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: Mielenz and King (1955)
Source: ONWI-312 (1981), p. 22

Property class: Compressive strength
Material: Bentonite (Na) (b)
 Formation: -
 Location: -
 Condition 1: Air dry (water ca. 10%)
 Condition 2: Density (bulk) = 2 t/m³
 Condition 3: -
Property/units: Compressive strength (uniaxial) (MPa)
 ranges from: 8.9
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: KBS TEKNISK RAPPORT 74 (1978), p. 14

Property class: Compressive strength
Material: Bentonite and Sand (a)
 Formation: -
 Location: Oregon
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (unconfined) (MPa)
 ranges from: ca. 0
 to: ca. 1.8
 as: Clay content (wt. %)
 ranges from: ca. 0 to: 50-70
Reference: Taylor et al (1980)
Source: RHO-BWI-SA-80 (1981), Fig. 4

Property class: Compressive strength
Material: Bentonite and Sand (b)
 Formation: -
 Location: Wyoming
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (unconfined) (MPa)
 ranges from: ca. 0
 to: ca. 3
 as: Clay content (wt. %)
 ranges from: ca. 0 to: 50-60
Reference: Taylor et al (1980)
Source: RHO-BWI-SA-80 (1981), Fig. 4

Property class: Compressive strength
Material: Kaolinite
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (unconfined) (psi)
 ranges from: 100.3 (6.9 x 10(-1) MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: Mielenz and King (1955)
Source: ONWI-312 (1981), p. 22

Property class: Compressive strength
Material: Oil Shales
 Formation: -
 Location: -
 Condition 1: High grade
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (MPa)
 ranges from: 35
 to: 138
 as: -
 ranges from: - to: -
Reference: Netherland et al (1975)
Source: ORNL/Sub/84-64794/1 (1985), p. 348

Property class: Compressive strength
Material: Oil Shales
 Formation: -
 Location: -
 Condition 1: Low grade
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (MPa)
 ranges from: 138
 to: 172
 as: -
 ranges from: - to: -
Reference: Netherland et al (1975)
Source: ORNL/Sub/84-64794/1 (1985), p. 348

Property class: Compressive strength
Material: Shale
 Formation: Arnheim and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3: -
Property/units: Compressive strength (uniaxial) (psi)
 ranges from: 1 x 10(4) (6.9 x 10(1) MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Compressive strength
Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian-Mississippian
 Condition 2: Intact
 Condition 3: Depth = 30 m
Property/units: Compressive strength (uniaxial) (MPa)
 ranges from: 13.8
 to: -
 as: -
 ranges from: - to: -
Reference: Dames and Moore (1978)
Source: ORNL/Sub/84-64794/1 (1985), p. 108

Property class: Compressive strength
Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3: -
Property/units: Compressive strength (uniaxial) (psi)
 ranges from: $2 \times 10(3)$ ($1.4 \times 10(1)$ MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Compressive strength
Material: Shale
 Formation: Hucknall Shale
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (psi)
 ranges from: $8.5 \times 10(3)$ ($5.9 \times 10(1)$ MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: Hobbs (1970)
Source: Y/OWI/TM36/6 (1978), p. 6-3

Property class: Compressive strength
Material: Shale
 Formation: Lewis Shale
 Location: New Mexico
 Condition 1: Moisture content 3.7 to 6.2%
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (psi)
 ranges from: 1,000 (6.9 MPa)
 to: 6,000 ($4.1 \times 10(1)$ MPa)
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 8-5

Property class: Compressive strength
Material: Shale
 Formation: Mancos Fm
 Location: New Mexico
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (psi)
 ranges from: 1,000 (6.9 MPa)
 to: 8,000 ($5.5 \times 10(1)$ MPa)
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 8-2

Property class: Compressive strength
Material: Shale
 Formation: Maquoketa Group
 Location: Indiana
 Condition 1: Illite dominant
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (MPa)
 ranges from: 11
 to: 115
 as: -
 ranges from: - to: -
Reference: Cobb Engineering (1975)
Source: ORNL/Sub/84-64794/1 (1985), p. 60

Property class: Compressive strength
Material: Shale (a)
 Formation: -
 Location: -
 Condition 1: Intact
 Condition 2: Range of properties
 Condition 3: -
Property/units: Compressive strength (uniaxial) (psi)
 ranges from: 70 ($4.8 \times 10(-1)$ MPa)
 to: $3.7 \times 10(4)$ ($2.5 \times 10(2)$ MPa)
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Compressive strength
Material: Shale (a)
 Formation: Bearpaw Shale
 Location: Montana
 Condition 1: Upper Cretaceous
 Condition 2: -
 Condition 3: -
Property/units: Compressive strength (kg/cm²)
 ranges from: 122 ($1.2 \times 10(1)$ MPa)
 to: 25 (2.5 MPa)
 as: Angle between sample axis and horizontal (deg)
 ranges from: 0 to: 40 +/- 10
Reference: Wright (1969)
Source: Y/OWI/TM36/6 (1978), p. 6-13

Property class: Compressive strength
 Material: Shale (a)
 Formation: Pierre Shale
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
 Property/units: Compressive strength (uniaxial) (psi)
 ranges from: $2.1 \times 10(3)$ ($1.4 \times 10(1)$ MPa)
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Compressive strength
 Material: Shale (b)
 Formation: -
 Location: -
 Condition 1: Typical illitic shale
 Condition 2: Intact
 Condition 3: -
 Property/units: Compressive strength (uniaxial) (psi)
 ranges from: $1 \times 10(4)$ ($6.9 \times 10(1)$ MPa)
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Compressive strength
 Material: Shale (b)
 Formation: Bearpaw Shale
 Location: Montana
 Condition 1: Upper Cretaceous
 Condition 2: -
 Condition 3: -
 Property/units: Compressive strength (kg/cm²)
 ranges from: 25 (2.5 MPa)
 to: 55 (5.4 MPa)
 as: Angle between sample axis and horizontal (deg)
 ranges from: 40 ± 10 to: 90
 Reference: Wright (1969)
 Source: Y/OWI/TM36/6 (1978), p. 6-13

Property class: Compressive strength
 Material: Shale (b)
 Formation: Pierre Shale
 Location: Great Plains
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Compressive strength (psi)
 ranges from: 70 ($4.8 \times 10(-1)$ MPa)
 to: 2,530 ($1.7 \times 10(1)$ MPa)
 as: -
 ranges from: - to: -
 Reference: Abel and Gentry (1975)
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Compressive strength
 Material: Shales
 Formation: -
 Location: Western Ohio
 Condition 1: Mean composition: (47%), quartz (~ Condition 2: Plus other clay: etc., etc.
 Condition 3: -
 Property/units: Compressive strength
 ranges from: 20 to: 32
 as: -
 ranges from: - to: -
 Reference: Cobb Engineering (1975)
 Source: ORNL/Sub/84-64794/1 (1985), p. 71

Property class: Compressive strength
 Material: Shales (a)
 Formation: -
 Location: -
 Condition 1: Tested at room temperature
 Condition 2: "Dry" specimens
 Condition 3: Forty-nine data points
 Property/units: Compressive strength (unconfined) (MPa)
 ranges from: 25.2 to: 113.6
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL-6241/V3 (in preparation) p. 110

Property class: Compressive strength
 Material: Shales (b)
 Formation: -
 Location: Various
 Condition 1: Various depths, compositions, etc.
 Condition 2: Represents many tests
 Condition 3: -
 Property/units: Compressive strength (unconfined) (psi)
 ranges from: <100 ($<6.9 \times 10(-1)$ MPa)
 to: $3.7 \times 10(4)$ ($2.5 \times 10(2)$ MPa)
 as: -
 ranges from: - to: -
 Reference: Thirteen refs
 Source: Y/OWI/TM36/6 (1978), p. A-4,5,6

Property class: Compressive strength
 Material: Smectite (Na), Kaolinite, Sand Mixtures (a)
 Formation: -
 Location: Osage, NY
 Condition 1: Kaolinite from Bath, SC
 Condition 2: Air dried
 Condition 3: -
 Property/units: Compressive strength (psi)
 ranges from: 76.5 ($5.3 \times 10(-1)$ MPa)
 to: 541.0 (3.7 MPa)
 as: -
 ranges from: - to: -
 Reference: Mielenz and King (1955)
 Source: ONWI-312 (1981), p. 24

Property class: Compressive strength
 Material: Smectite (Na), Kaolinite, Sand
 Mixtures (b)

Formation: -
 Location: Osage, NY

Condition 1: Kaolinite from Bath, SC
 Condition 2: Optimum moisture content
 Condition 3: -

Property/units: Compressive strength (psi)
 ranges from: 9.1 ($6.3 \times 10(-2)$ MPa)
 to: 85.5 ($5.9 \times 10(-1)$ MPa)
 as: -

ranges from: - to: -

Reference: Mielenz and King (1955)
 Source: ONWI-312 (1981), p. 24

Property class: Friction angle
 Material: Argillite

Formation: Eleiana Argillite
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Friction angle (internal)
 (deg)

ranges from: 35
 to: -
 as: -

ranges from: - to: -

Reference: Y/OWI/TM-36/6 (1978)
 Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Friction angle
 Material: Clay

Formation: Blue Clay
 Location: Italy
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Friction angle (angle of
 shear resistance) (deg)

ranges from: 25
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel
 Cycle v.6 (1985), p. 54

Property class: Friction angle
 Material: Clay

Formation: Boom Clay
 Location: Belgium
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Friction angle (angle of
 shear resistance) (deg)

ranges from: 19
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel
 Cycle v.6 (1985), p. 54

Property class: Friction angle
 Material: Illite (Na) (a)

Formation: -

Location: -

Condition 1: 0 g NaCl/liter

Condition 2: -

Condition 3: -

Property/units: Friction angle (residual)
 (tan)

ranges from: 0.3
 to: 0.7

as: Quartz content (% dry wt.)
 ranges from: 0 to: 100

Reference: Mitchell (1976)

Source: ONWI-486 (1983), p. 47

Property class: Friction angle
 Material: Illite (Na) (b)

Formation: -

Location: -

Condition 1: 30 g NaCl/liter

Condition 2: -

Condition 3: -

Property/units: Friction angle (residual)
 (tan)

ranges from: 0.47
 to: 0.7

as: Quartz content (% dry wt.)
 ranges from: 0 to: 100

Reference: Mitchell (1976)

Source: ONWI-486 (1983), p. 47

Property class: Friction angle
 Material: Kaolinite

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Friction angle (residual)
 (tan)

ranges from: 0.27
 to: 0.7

as: Quartz content (% dry wt.)
 ranges from: 0 to: 100

Reference: Mitchell (1976)

Source: ONWI-486 (1983), p. 47

Property class: Friction angle
 Material: Shale

Formation: Arnheim and Waynesville Fms

Location: Ohio

Condition 1: Ordovician

Condition 2: Intact

Condition 3: -

Property/units: Friction angle (deg)

ranges from: 23.4
 to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Friction angle
 Material: Shale

Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3: -

Property/units: Friction angle (deg)
 ranges from: 22
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Friction angle
 Material: Shale (a)

Formation: -
 Location: -
 Condition 1: Intact
 Condition 2: Range of properties
 Condition 3: -

Property/units: Friction angle (deg)
 ranges from: 4.2
 to: 56
 as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Friction angle
 Material: Shale (a)

Formation: Pierre Shale
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -

Property/units: Friction angle (deg)
 ranges from: 5.3
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Friction angle
 Material: Shale (b)

Formation: -
 Location: -
 Condition 1: Typical illitic shale
 Condition 2: Intact
 Condition 3: -

Property/units: Friction angle (deg)
 ranges from: 26
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Friction angle
 Material: Shale (b)

Formation: Pierre Shale
 Location: Great Plains
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Friction angle (internal)
 (deg)

ranges from: 8
 to: 25
 as: -

ranges from: - to: -

Reference: Abel and Gentry (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Friction angle
 Material: Shale (c)

Formation: -
 Location: -
 Condition 1: Intact
 Condition 2: Range of properties
 Condition 3: -

Property/units: Friction angle (dilation
 angle) (deg)

ranges from: +5
 to: -5
 as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Friction angle
 Material: Shale (d)

Formation: -
 Location: -
 Condition 1: Summary
 Condition 2: 7 data points
 Condition 3: "dry"; tested at room
 temperature

Property/units: Friction angle (internal)
 (deg)

ranges from: 14.2
 to: 51.0
 as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V1 (in preparation) p. 47

Property class: Friction angle
 Material: Smectite (Na) (a)

Formation: -
 Location: -
 Condition 1: 0 g NaCl/liter
 Condition 2: -
 Condition 3: -

Property/units: Friction angle (residual)
 (tan)

ranges from: 0.09
 to: 0.7
 as: Quartz content (% dry wt.)

ranges from: 0 to: 100

Reference: Mitchell (1976)

Source: ONWI-486 (1983), p. 47

Property class: Friction angle
 Material: Smectite (Na) (b)

Formation: -
 Location: -
 Condition 1: 30 g NaCl/liter
 Condition 2: -
 Condition 3: -
 ranges from: 0.18
 to: 0.7
 as: Quartz content (% dry wt.)

ranges from: 0 to: 100
 Reference: Mitchell (1976)
 Source: ONWI-486 (1983), p. 47

Property class: Miscellaneous
 Material: Bentonite

Formation: -
 Location: -
 Condition 1: Wet
 Condition 2: 0.5-mm spaces
 Condition 3: -

Property/units: Swelling distance (mm)
 ranges from: 1
 to: 11
 as: Time (hr)
 ranges from: 1 to: 100

Reference: LeBell (1978)
 Source: ONWI-312 (1981), p. 16

Property class: Miscellaneous
 Material: Shale

Formation: -
 Location: -
 Condition 1: Constructibility Indices
 Condition 2: -
 Condition 3: -

Property/units: Ratio of strength to
 overburden stress
 ranges from: 1.3
 to: 6.0
 as: -
 ranges from: - to: -

Reference: -
 Source: ORNL-6241/V1 (In preparation) p. 53

Property class: Plasticity (LI)

Material: Shale

Formation: Bearpaw Shale
 Location: Montana
 Condition 1: Upper Cretaceous
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquidity index)
 ranges from: -0.11
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Y/ONWI/TM36/6 (1978), p. 6-1

Property class: Plasticity (LL)

Material: Bentonite

Formation: -
 Location: Wyoming
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 553.1
 to: -
 as: -
 ranges from: - to: -

Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (LL)

Material: Bentonite (a)

Formation: -
 Location: Oregon
 Condition 1: 20 - 160 mesh
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 209.6
 to: -
 as: -
 ranges from: - to: -

Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (LL)

Material: Bentonite (b)

Formation: -
 Location: Oregon
 Condition 1: Minus 200 mesh
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 212.69
 to: -
 as: -
 ranges from: - to: -

Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (LL)

Material: Bentonite (Na)

Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 260
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: AECL-7825 (1984), p. 12

Property class: Plasticity (LL)
 Material: Bentonite (Na) (a)

Formation: -
 Location: -
 Condition 1: MX-80
 Condition 2: 50% sand
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 98
 to: -
 as: -

ranges from: - to: -

Reference: -
 Source: AECL-7825 (1984), p. 12

Property class: Plasticity (LL)
 Material: Clay

Formation: -
 Location: Hanford
 Condition 1: Ringold clay C
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 44.6
 to: -
 as: -

ranges from: - to: -

Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (LL)
 Material: Clay

Formation: -
 Location: Hanford
 Condition 1: Ringold clay D
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 63.9
 to: -
 as: -

ranges from: - to: -

Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (LL)
 Material: Clay

Formation: Blue Clay
 Location: Italy
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 50
 to: -
 as: -

ranges from: - to: -

Reference: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Plasticity (LL)
 Material: Clay

Formation: Boom Clay
 Location: Belgium
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 77.5
 to: -
 as: -

ranges from: - to: -

Reference: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Plasticity (LL)

Material: Clay
 Formation: Oxford Clay
 Location: England
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 55
 to: -
 as: -

ranges from: - to: -

Reference: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Plasticity (LL)

Material: Illite (Ca)
 Formation: -
 Location: Jackson County, OH
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 69
 to: -
 as: -

ranges from: - to: -

Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)

Material: Illite (Ca) (a)
 Formation: -
 Location: Filthian, IL
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (liquid limit) (%)
 ranges from: 90
 to: -
 as: -

ranges from: - to: -

Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)
 Material: Illite (Ca) (b)

Formation: -
 Location: Grundy County, IL
 Condition 1: 5 % smectite layers.
 Condition 2: -
 Condition 3: -
 ranges from: 100
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)
 Material: Kaolinite (Ca)

Formation: -
 Location: Anna, IL
 Condition 1: -
 Condition 2: -
 Condition 3: -
 ranges from: 73
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)
 Material: Kaolinite (Ca)

Formation: -
 Location: Dry Branch, GA
 Condition 1: -
 Condition 2: -
 Condition 3: -
 ranges from: 34
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)

Material: Shale (a)
 Formation: Pierre Shale
 Location: Great Plains
 Condition 1: Mixed-layer illite-smectite
 dominant
 Condition 2: 60-80% clays
 Condition 3: -
 ranges from: 36
 to: 113
 as: -
 ranges from: - to: -

Reference: Tourtelot (1962)
 Source: ORNL/Sub/84-64794/1 (1985), p. 291

Property class: Plasticity (LL)
 Material: Shale (b)

Formation: Pierre Shale
 Location: Great Plains
 Condition 1: -
 Condition 2: -
 Condition 3: -
 ranges from: 55
 to: 202
 as: -
 ranges from: - to: -

Reference: Abel and Gentry (1975)
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Plasticity (LL)

Material: Shales, Mudstones, Siltstones
 Formation: -
 Location: Various
 Condition 1: Many different formations,
 depths, etc.
 Condition 2: Represents over 125 tests
 Condition 3: -
 ranges from: 17.8
 to: 224
 as: -
 ranges from: - to: -

Reference: -
 Source: Y/ONWI/TM36/6 (1978), p. 6-20 to 6-26

Property class: Plasticity (LL)

Material: Smectite (Ca)
 Formation: -
 Location: Belle Fourche, SD
 Condition 1: -
 Condition 2: -
 Condition 3: -
 ranges from: 177
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)

Material: Smectite (Ca)
 Formation: -
 Location: Cheto, AZ
 Condition 1: -
 Condition 2: -
 Condition 3: -
 ranges from: 155
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)

Material: Smectite (Ca)

Formation: -

Location: Omsted, IL

Condition 1: 25% illite layers.

Condition 2: -

Condition 3: -

Property/units: Plasticity (liquid limit) (%)

ranges from: 123

to: -

as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 43

Property class: Plasticity (LL)

Material: Smectite (Ca)

Formation: -

Location: Pontotoc, MS

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Plasticity (liquid limit) (%)

ranges from: 166

to: -

as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PI)

Material: Bentonite

Formation: -

Location: Wyoming

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic index) (%)

ranges from: 519.5

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PI)

Material: Bentonite (a)

Formation: -

Location: Oregon

Condition 1: 20 - 160 mesh

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic index) (%)

ranges from: 168.58

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PI)

Material: Bentonite (b)

Formation: -

Location: Oregon

Condition 1: Minus 200 mesh

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic index) (%)

ranges from: 174.6

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PI)

Material: Bentonite (Na) (a)

Formation: -

Location: Wyoming

Condition 1: MX-80

Condition 2: -

Condition 3: -

Property/units: Plasticity (plasticity index) (%)

ranges from: 210

to: -

as: -

ranges from: - to: -

Reference: -

Source: AECL-7825 (1984), p. 12

Property class: Plasticity (PI)

Material: Bentonite (Na) (b)

Formation: -

Location: Wyoming

Condition 1: MX-80

Condition 2: 50% sand

Condition 3: -

Property/units: Plasticity (plasticity index) (%)

ranges from: 79

to: -

as: -

ranges from: - to: -

Reference: -

Source: AECL-7825 (1984), p. 12

Property class: Plasticity (PI)

Material: Clay

Formation: -

Location: Hanford

Condition 1: Ringold clay C

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic index) (%)

ranges from: 18.8

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PI)
 Material: Clay

Formation: -
 Location: Hanford
 Condition 1: Ringold clay D
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic index)
 (%)

ranges from: 40.8
 to: -
 as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PI)

Material: Clay

Formation: Porters Creek Clay
 Location: Louisiana
 Condition 1: Smectite, kaolinite, illite,
 etc.
 Condition 2: Quartz 5 to 50%
 Condition 3: -

Property/units: Plasticity (plasticity index)
 (%)

ranges from: 40
 to: -
 as: -

ranges from: - to: -

Reference: Boutwell (personal communication)
 (1980)

Source: ORNL/Sub/84-64794/1 (1985), p. 173

Property class: Plasticity (PI)

Material: Illite

Formation: -
 Location: -
 Condition 1: Non-clay fraction, quartz
 sand
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plasticity index)
 (%)

ranges from: 0
 to: 90
 as: Clay fraction (%)

ranges from: 0 to: 100

Reference: Lambe and Whitman (1969)
 Source: ONWI-486 (1983), p. 45

Property class: Plasticity (PI)

Material: Kaolinite

Formation: -
 Location: -
 Condition 1: Non-clay fraction, quartz
 sand
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plasticity index)
 (%)

ranges from: 0
 to: 35
 as: Clay fraction (%)

ranges from: 0 to: 100

Reference: Lambe and Whitman (1969)
 Source: ONWI-486 (1983), p. 45

Property class: Plasticity (PI)

Material: Shale

Formation: Pierre Shale
 Location: Great Plains
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plasticity index)
 (%)

ranges from: 30
 to: 110
 as: -

ranges from: - to: -

Reference: Abel and Gentry (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Plasticity (PI)

Material: Shales, Mudstones, Siltstones

Formation: -
 Location: Various
 Condition 1: Many different formations,
 depths, etc.
 Condition 2: Represents over 125 tests
 Condition 3: -

Property/units: Plasticity (plasticity index)
 (%)

ranges from: 1.8
 to: 192
 as: -

ranges from: - to: -

Reference: -

Source: Y/ONWI/TM36/6 (1978), p. 6-20 to 6-26

Property class: Plasticity (PI)

Material: Smectite (Na)

Formation: -
 Location: -
 Condition 1: Non-clay fraction, quartz
 sand
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plasticity index)
 (%)

ranges from: 0
 to: 500
 as: Clay fraction (%)

ranges from: 0 to: 70

Reference: Lambe and Whitman (1969)

Source: ONWI-486 (1983), p. 45

Property class: Plasticity (PL)

Material: Bentonite

Formation: -
 Location: Wyoming
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 33.6
 to: -
 as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PL)

Material: Bentonite (a)

Formation: -

Location: Oregon

Condition 1: 20 - 160 mesh

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 41.0

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PL)

Material: Bentonite (b)

Formation: -

Location: Oregon

Condition 1: Minus 200 mesh

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 38.1

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PL)

Material: Bentonite (Na) (a)

Formation: -

Location: Wyoming

Condition 1: MX-80

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 50

to: -

as: -

ranges from: - to: -

Reference: -

Source: AECL-7825 (1984), p. 12

Property class: Plasticity (PL)

Material: Bentonite (Na) (b)

Formation: -

Location: Wyoming

Condition 1: MX-80

Condition 2: 50% sand

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 19

to: -

as: -

ranges from: - to: -

Reference: -

Source: AECL-7825 (1984), p. 12

Property class: Plasticity (PL)

Material: Clay

Formation: -

Location: Hanford

Condition 1: Ringold clay C

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 25.8

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PL)

Material: Clay

Formation: -

Location: Hanford

Condition 1: Ringold clay D

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 23.1

to: -

as: -

ranges from: - to: -

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (PL)

Material: Clay

Formation: Blue Clay

Location: Italy

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 25

to: -

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 34

Property class: Plasticity (PL)

Material: Clay

Formation: Boom Clay

Location: Belgium

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Plasticity (plastic limit)

(%)

ranges from: 26.5

to: -

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 34

Property class: Plasticity (PL)
 Material: Clay

Formation: Oxford Clay
 Location: England
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 26
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Plasticity (PL)
 Material: Illite (Ca)

Formation: -
 Location: Jackson County, OH
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 36
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Illite (Ca) (a)

Formation: -
 Location: Fithian, IL
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 40
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Illite (Ca) (b)

Formation: -
 Location: Grundy County, IL
 Condition 1: 5% smectite layers.
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 42
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Kaolinite (Ca)

Formation: -
 Location: Anna, IL
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 36
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Kaolinite (Ca)

Formation: -
 Location: Dry Branch, GA
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 26
 to: -
 as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Shale (a)

Formation: Pierre Shale
 Location: Great Plains
 Condition 1: 60-80% clay minerals
 Condition 2: Mixed layer illite-smectite dominant
 Condition 3: Plus smectite and illite; minor kaolinite and chlorite

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 20
 to: 62
 as: -

ranges from: - to: -

Reference: Tourtelot (1962)

Source: ORNL/Sub/84-64794/1 (1985), p. 291

Property class: Plasticity (PL)

Material: Shale (b)

Formation: Pierre Shale
 Location: Great Plains
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Plasticity (plastic limit)
 (%)

ranges from: 22
 to: 39
 as: -

ranges from: - to: -

Reference: Abel and Gentry (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Plasticity (PL)
 Material: Shales, Mudstones, Siltstones
 Formation: -
 Location: Various
 Condition 1: Many different formations,
 depths, etc.
 Condition 2: Represents over 125 tests
 Condition 3: -
 Property/units: Plasticity (plastic limit)
 (%)
 ranges from: 16.0
 to: 45.5
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 6-20 to 6-26

Property class: Plasticity (PL)
 Material: Smectite (Ca)
 Formation: -
 Location: Belle Fourche, SD
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Plasticity (plastic limit)
 (%)
 ranges from: 63
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Smectite (Ca)
 Formation: -
 Location: Cheto, AZ
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Plasticity (plastic limit)
 (%)
 ranges from: 65
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Smectite (Ca)
 Formation: -
 Location: Omsted, IL
 Condition 1: 25% illite layers.
 Condition 2: -
 Condition 3: -
 Property/units: Plasticity (plastic limit)
 (%)
 ranges from: 79
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (PL)
 Material: Smectite (Ca)
 Formation: -
 Location: Pontotoc, MS
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Plasticity (plastic limit)
 (%)
 ranges from: 65
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: ONWI-486 (1983), p. 43

Property class: Plasticity (SL)
 Material: Bentonite (a)
 Formation: -
 Location: Oregon
 Condition 1: 20 - 160 mesh
 Condition 2: -
 Condition 3: -
 Property/units: Plasticity (shrinkage limit)
 (%)
 ranges from: 8.47
 to: -
 as: -
 ranges from: - to: -
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (SL)
 Material: Bentonite (b)
 Formation: -
 Location: Oregon
 Condition 1: Minus 200 mesh
 Condition 2: -
 Condition 3: -
 Property/units: Plasticity (shrinkage limit)
 (%)
 ranges from: 8.96
 to: -
 as: -
 ranges from: - to: -
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Plasticity (SL)
 Material: Clay
 Formation: -
 Location: Hanford
 Condition 1: Ringold clay D
 Condition 2: -
 Condition 3: -
 Property/units: Plasticity (shrinkage limit)
 (%)
 ranges from: 19.75
 to: -
 as: -
 ranges from: - to: -
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Poisson's ratio
Material: Argillite
 Formation: Eleana Argillite
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.30
 to: -
 as: -
 ranges from: - to: -
Reference: Y/OWI/TM-36/6 (1978)
Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Poisson's ratio
Material: Bentonite
 Formation: -
 Location: Wyoming
 Condition 1: Density = 2 t/m³
 Condition 2: 10% water
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.15
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: ONWI-486 (1983), p. 63

Property class: Poisson's ratio
Material: Oil Shales
 Formation: -
 Location: -
 Condition 1: High grade
 Condition 2: -
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.2
 to: 0.3
 as: -
 ranges from: - to: -
Reference: Netherland et al (1975)
Source: ORNL/Sub/84-64794/1 (1985), p. 348

Property class: Poisson's ratio
Material: Oil Shales
 Formation: -
 Location: -
 Condition 1: Low grade
 Condition 2: -
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.15
 to: 0.20
 as: -
 ranges from: - to: -
Reference: Netherland et al (1975)
Source: ORNL/Sub/84-64794/1 (1985), p. 348

Property class: Poisson's ratio
Material: Shale
 Formation: Arnheim and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.1
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Poisson's ratio
Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.25
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Poisson's ratio
Material: Shale
 Formation: Pierre Shale
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.2
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Poisson's ratio
Material: Shale (a)
 Formation: -
 Location: -
 Condition 1: Intact
 Condition 2: Range of properties
 Condition 3: -
Property/units: Poisson's ratio
 ranges from: 0.03
 to: 0.50
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Poisson's ratio

Material: Shale (b)

Formation: -

Location: -

Condition 1: Typical illitic shale

Condition 2: Intact

Condition 3: -

Property/units: Poisson's ratio

ranges from: 0.15

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Poisson's ratio

Material: Shales (a)

Formation: -

Location: -

Condition 1: Tested at room temperature

Condition 2: "Dry" specimens

Condition 3: Thirty-four data points

Property/units: Poisson's ratio

ranges from: 0.11

to: 0.31

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V3 (In preparation) p. 110

Property class: Poisson's ratio

Material: Shales (b)

Formation: -

Location: Various

Condition 1: Various formations, depths,
etc.

Condition 2: Represents many tests

Condition 3: -

Property/units: Poisson's ratio

ranges from: 0.03

to: 0.77

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. A-11

Property class: Shear

Material: Bentonite (Na) (a)

Formation: -

Location: -

Condition 1: Water content ca. 10 %

Condition 2: Calculated values

Condition 3: -

Property/units: Shear strength (kPa)

ranges from: 1,600 (1.6 MPa)

to: <15 (<1.5 x 10(-2) MPa)

as: Density (bulk) (t/m(3))

ranges from: 2.2 to: 1.05

Reference: -

Source: KBS TEKNISK RAPPORT 74 (1978), p.16

Property class: Shear

Material: Bentonite (Na) (b)

Formation: -

Location: -

Condition 1: Air dry (water ca. 10%)

Condition 2: Density (bulk) = 2 t/m(3)

Condition 3: -

Property/units: Shear strength (MPa)

ranges from: 4.5

to: -

as: -

ranges from: - to: -

Reference: -

Source: KBS TEKNISK RAPPORT 74 (1978), p. 14

Property class: Shear

Material: Clay

Formation: Blue Clay

Location: Italy

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Shear strength (undrained)
(MPa)

ranges from: 1.5

to: -

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel
Cycle v.6 (1985), p. 54

Property class: Shear

Material: Clay

Formation: Boom Clay

Location: Belgium

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Shear strength (undrained)
(MPa)

ranges from: 0.6

to: -

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel
Cycle v.6 (1985), p. 54

Property class: Shear

Material: Clay

Formation: Oxford Clay

Location: England

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Shear strength (undrained)
(MPa)

ranges from: 1.2

to: -

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel
Cycle v.6 (1985), p. 54

Property class: Shear
Material: Shale
 Formation: -
 Location: -
 Condition 1: Typical illitic shale
 Condition 2: Intact
 Condition 3: -
Property/units: Shear modulus (psi)
 ranges from: $6.2 \times 10(5)$ ($4.3 \times 10(3)$ MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Shear
Material: Shale
 Formation: Arnheim and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3: -
Property/units: Shear modulus (psi)
 ranges from: $6.8 \times 10(5)$ ($4.7 \times 10(3)$ MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Shear
Material: Shale
 Formation: Chagrin Shale
 Location: Ohio
 Condition 1: Devonian
 Condition 2: Intact
 Condition 3: -
Property/units: Shear modulus (psi)
 ranges from: $6.8 \times 10(4)$ ($4.7 \times 10(2)$ MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Shear
Material: Shale
 Formation: Pierre Shale
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
Property/units: Shear modulus (psi)
 ranges from: $58.3 \times 10(3)$ ($4 \times 10(2)$ MPa)
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Shear
Material: Shales (a)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
Property/units: Shear modulus (Pa $\times 10(10)$)
 ranges from: 0.1 ($1 \times 10(3)$ MPa)
 to: 100 ($1 \times 10(6)$ MPa)
 as: Depth (m)
 ranges from: 0 to: 6,000
Reference: Three refs
Source: ORNL-6241/V2 (in preparation) p. 199

Property class: Shear
Material: Shales (b)
 Formation: -
 Location: Various
 Condition 1: Various formations, depths, etc.
 Condition 2: Represents several tests
 Condition 3: -
Property/units: Shear modulus (psi)
 ranges from: $1.7 \times 10(6)$ ($1.2 \times 10(4)$ MPa)
 to: $3.6 \times 10(6)$ ($2.5 \times 10(4)$ MPa)
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. A-10

Property class: Shear (?)
Material: Clay
 Formation: Porters Creek Clay
 Location: Louisiana
 Condition 1: Smectite, kaolinite, illite, etc.
 Condition 2: Quartz 5 to 50%
 Condition 3: -
Property/units: Strength (MPa)
 ranges from: 0.19
 to: -
 as: -
 ranges from: - to: -
Reference: Boutwell (personal communication) (1980)
Source: ORNL/Sub/84-64794/1 (1985), p. 173

Property class: Swelling
Material: Bentonite (a)
 Formation: -
 Location: -
 Condition 1: Plus natural silt
 Condition 2: Air dry (ca. 5% water)
 Condition 3: Laterally confined; axial load, 10 kPa
Property/units: Swelling (%)
 ranges from: 5
 to: 20
 as: Bentonite content (%)
 ranges from: 10 to: 20
Reference: -
Source: KBS TEKNISK RAPPORT 9 (1977), p. 5

Property class: Swelling
Material: Bentonite (b)
 Formation: -
 Location: -
 Condition 1: Plus quartz
 Condition 2: 10 to 15% water content
 Condition 3: Allowed to swell freely
Property/units: Swelling (%)
 ranges from: 15
 to: 30
 as: -
 ranges from: - to: -
Reference: VBB company report
Source: KBS TEKNISK RAPPORT 9 (1977), p. 6

Property class: Swelling
Material: Bentonite (c)
 Formation: -
 Location: -
 Condition 1: 1-psl surcharge
 Condition 2: Optimum water content, maximum density
 Condition 3: -
Property/units: Swelling (%)
 ranges from: 1
 to: 50
 as: % clay size
 ranges from: 5 to: 18
Reference: Two refs
Source: ONWI-486 (1983), p. 49

Property class: Swelling
Material: Illite
 Formation: -
 Location: -
 Condition 1: 1-psl surcharge
 Condition 2: -
 Condition 3: -
Property/units: Swelling (%)
 ranges from: <2
 to: 20
 as: % clay size
 ranges from: <20 to: 45
Reference: Two refs
Source: ONWI-486 (1983), p. 49

Property class: Swelling
Material: Illite and Bentonite (a)
 Formation: -
 Location: -
 Condition 1: 1:1 illite:bentonite ratio
 Condition 2: 1-psl surcharge
 Condition 3: Optimum water content, maximum density
Property/units: Swelling (%)
 ranges from: 1
 to: 54
 as: % clay size
 ranges from: 5 to: 27
Reference: Two refs
Source: ONWI-486 (1983), p. 49

Property class: Swelling
Material: Illite and Bentonite (b)
 Formation: -
 Location: -
 Condition 1: 3:1 illite:bentonite ratio
 Condition 2: 1-psl surcharge
 Condition 3: Optimum water content, maximum density
Property/units: Swelling (%)
 ranges from: <2
 to: 30
 as: % clay size
 ranges from: <20 to: 40
Reference: Two refs
Source: ONWI-486 (1983), p. 49

Property class: Swelling
Material: Illite and Kaolinite
 Formation: -
 Location: -
 Condition 1: 1:1 illite:kaolinite ratio
 Condition 2: 1-psl surcharge
 Condition 3: Optimum water content, maximum density
Property/units: Swelling (%)
 ranges from: <2
 to: <10
 as: % clay size
 ranges from: <20 to: 55
Reference: Two refs
Source: ONWI-486 (1983), p. 49

Property class: Swelling
Material: Kaolinite
 Formation: -
 Location: -
 Condition 1: 1-psl surcharge
 Condition 2: Optimum water content, maximum density
 Condition 3: -
Property/units: Swelling (%)
 ranges from: <2
 to: 4
 as: % clay size
 ranges from: <20 to: 60
Reference: Two refs
Source: ONWI-486 (1983), p. 49

Property class: Swelling
Material: Kaolinite and Bentonite
 Formation: -
 Location: -
 Condition 1: 6:1 kaolinite:bentonite ratio
 Condition 2: 1-psl surcharge
 Condition 3: Optimum water content, maximum density
Property/units: Swelling (%)
 ranges from: 2
 to: 35
 as: % clay size
 ranges from: 10 to: 30
Reference: Two refs
Source: ONWI-486 (1983), p. 49

Property class: Swelling

Material: Shale

Formation: Pierre Shale
Location: Great Plains

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Swelling (potential) (%)

ranges from: 3

to: 5

as: -

ranges from: - to: -

Reference: Abel and Gentry (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Swelling

Material: Shale

Formation: Pierre Shale (equivalent)
Location: Canada

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Swelling (potential) (%)

ranges from: 2

to: 20

as: -

ranges from: - to: -

Reference: Abel and Gentry (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Swelling pressure

Material: Bentonite

Formation: -
Location: Oregon
Condition 1: Mixed with sand

Condition 2: -

Condition 3: -

Property/units: Swelling pressure (MPa)

ranges from: ca. 0

to: ca. 1.8

as: Bentonite content (%)

ranges from: ca. 10 to: ca. 69

Reference: Smith et al (1980)

Source: AECL-7812 (1983), p. 34

Property class: Swelling pressure

Material: Bentonite

Formation: -
Location: Wyoming
Condition 1: Mixed with sand

Condition 2: -

Condition 3: -

Property/units: Swelling pressure (MPa)

ranges from: ca. 0

to: ca. 2.2

as: Bentonite content (%)

ranges from: ca. 10 to: ca. 70

Reference: Smith et al (1980)

Source: AECL-7812 (1983), p. 34

Property class: Swelling pressure

Material: Bentonite (a)

Formation: -

Location: -

Condition 1: Plus natural silt

Condition 2: Air dry (5% water, initially)

Condition 3: Laterally confined; axial load, 10 kPa

Property/units: Swelling pressure (kPa)

ranges from: 30 (0.03 MPa) (?)

to: 110 (0.11 MPa) (?)

as: Bentonite content (%)

ranges from: 10 to: 20

Reference: -

Source: KBS TEKNISK RAPPORT 9 (1977), p. 6

Property class: Swelling pressure

Material: Bentonite (b)

Formation: -

Location: -

Condition 1: Plus quartz

Condition 2: 10 to 15% water content

Condition 3: At constant volume

Property/units: Swelling pressure (kPa)

ranges from: 30 (0.03 MPa) (?)

to: 200 (0.20 MPa) (?)

as: -

ranges from: - to: -

Reference: VBB company report

Source: KBS TEKNISK RAPPORT 9 (1977), p. 6

Property class: Swelling pressure

Material: Bentonite (c)

Formation: -

Location: -

Condition 1: Measured at 20 deg C

Condition 2: Used distilled water

Condition 3: -

Property/units: Swelling pressure (MPa)

ranges from: 0.7

to: ca. 70

as: Density (dry) (Mg/m³)

ranges from: 1.75 to: 2.2

Reference: Pusch (1980)

Source: AECL-7812 (1983), p. 33

Property class: Swelling pressure

Material: Bentonite (Ca)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Swelling pressure (MPa)

ranges from: 31.4

to: -

as: Density (g/cm³) (?)

ranges from: 2.11 to: -

Reference: -

Source: ONWI-312 (1981), p. 31

Property class: Swelling pressure
 Material: Bentonite (Na) (a)
 Formation: -
 Location: -
 Condition 1: Confined
 Condition 2: Density at water saturation
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: >10
 to: -
 as: -
 ranges from: - to: -
 Reference: Pusch (1979)
 Source: ONWI-312 (1981), p. 15

Property class: Swelling pressure
 Material: Bentonite (Na) (b)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: 57.7
 to: -
 as: Density (initial) (presumed
 g/cm(3))
 ranges from: 2.13 to: -
 Reference: -
 Source: ONWI-312 (1981), p. 31

Property class: Swelling pressure
 Material: Bentonite (Na) (c)
 Formation: -
 Location: -
 Condition 1: 50% sand
 Condition 2: -
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: 21.7
 to: -
 as: Density (initial) (presumed
 g/cm(3))
 ranges from: 2.09 to: -
 Reference: -
 Source: ONWI-312 (1981), p. 31

Property class: Swelling pressure
 Material: Bentonite (Na) (d)
 Formation: -
 Location: -
 Condition 1: Density (g/cm(3)) ca. 2.2
 Condition 2: Time 373 days
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: ca. 72
 to: -
 as: -
 ranges from: - to: -
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), p. 6

Property class: Swelling pressure
 Material: Bentonite (Na) (e)
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: 50% sand
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: ca. 3
 to: ca. 8
 as: Density (Mg/m(3))
 ranges from: 1.856 to: 2.055
 Reference: -
 Source: AECL-7825 (1984), p. 16

Property class: Swelling pressure
 Material: Bentonite (Na) (f)
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: Time dependent
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: ca. 2
 to: ca. 20
 as: Density (dry) (Mg/m(3))
 ranges from: 1.556 to: 1.774
 Reference: -
 Source: AECL-7825 (1984), p. 16

Property class: Swelling pressure
 Material: Bentonite (Na) (g)
 Formation: -
 Location: Wyoming
 Condition 1: MX-80
 Condition 2: Compacted air-dry (water ca.
 10%)
 Condition 3: Curve D
 Property/units: Swelling pressure (MPa)
 ranges from: 1
 to: 8
 as: Density (bulk) (t/m(3))
 ranges from: ca. 1.8 to: ca. 2.3
 Reference: -
 Source: KBS TEKNISK RAPPORT 74 (1978), p. 6

Property class: Swelling pressure
 Material: Bentonite (Na) (h)
 Formation: -
 Location: Wyoming
 Condition 1: Calculated based on dry
 density
 Condition 2: -
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: 2
 to: 23
 as: Density (dry) (t/m(3))
 ranges from: 1.1 to: 1.7
 Reference: Pusch (1978)
 Source: ONWI-486 (1983), p. 51

Property class: Swelling pressure
 Material: Bentonite (Na) (i)
 Formation: -
 Location: Wyoming
 Condition 1: Calculated, water saturated
 Condition 2: -
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: 3
 to: 26
 as: Density (bulk) (t/m(3))
 ranges from: 1.7 to: 2.1
 Reference: Pusch (1978)
 Source: ONWI-486 (1983), p. 51

Property class: Swelling pressure
 Material: Bentonite (Na) (j)
 Formation: -
 Location: Wyoming
 Condition 1: Exposed to external water at
 constant volume
 Condition 2: Measured
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: 3
 to: 27
 as: Density (t/m(3))
 ranges from: 1.9 to: 2.3
 Reference: Pusch (1978)
 Source: ONWI-486 (1983), p. 51

Property class: Swelling pressure
 Material: Bentonite and Sand (a)
 Formation: -
 Location: Oregon
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: ca. 0
 to: ca. 1.8
 as: Clay content (wt. %)
 ranges from: ca. 10 to: ca. 70
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), Fig. 3

Property class: Swelling pressure
 Material: Bentonite and Sand (b)
 Formation: -
 Location: Wyoming
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: ca. 0
 to: ca. 2.2
 as: Clay content (wt. %)
 ranges from: ca. 10 to: ca. 70
 Reference: Taylor et al (1980)
 Source: RHO-BWI-SA-80 (1981), Fig. 3

Property class: Swelling pressure
 Material: Shale
 Formation: -
 Location: -
 Condition 1: MX-80
 Condition 2: Water content ca. 10%
 Condition 3: -
 Property/units: Swelling pressure (MPa)
 ranges from: 10
 to: 0.5
 as: Density (bulk) (t/m(3))
 ranges from: 2.2 to: 1.2
 Reference: -
 Source: KBS TEKNISK RAPPORT 74 (1978), p. 7

Property class: Tensile strength
 Material: Argillite
 Formation: Eleana Argillite
 Location: -
 Condition 1: Calculated value
 Condition 2: -
 Condition 3: -
 Property/units: Tensile strength (MPa)
 ranges from: 3.5
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Proc NEA Workshop OECD (1979b), p. 81

Property class: Tensile strength
 Material: Shale
 Formation: Arnhem and Waynesville Fms
 Location: Ohio
 Condition 1: Ordovician
 Condition 2: Intact
 Condition 3: -
 Property/units: Tensile strength (psi)
 ranges from: 200 (1.4 MPa)
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Property class: Tensile strength
 Material: Shale (a)
 Formation: -
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
 Property/units: Tensile strength (psi)
 ranges from: 0 (0 MPa) (?)
 to: 1,540 (1.1 x 10(1) MPa)
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Tensile strength
 Material: Shale (b)

Formation: -

Location: -

Condition 1: Typical illitic shale
 Condition 2: Intact

Condition 3: -

Property/units: Tensile strength (psi)

ranges from: 200 (1.4×10^6 MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Tensile strength

Material: Shale (c)

Formation: Chagrin Shale

Location: Ohio

Condition 1: Devonian-Mississippian

Condition 2: Intact

Condition 3: Depth = 30 m

Property/units: Tensile strength (MPa)

ranges from: 0.34

to: -

as: -

ranges from: - to: -

Reference: Dames and Moore (1978)

Source: ORNL/Sub/84-64794/1 (1985), p. 108

Property class: Tensile strength

Material: Shale (d)

Formation: Chagrin Shale

Location: Ohio

Condition 1: Devonian

Condition 2: Intact

Condition 3: -

Property/units: Tensile strength (psi)

ranges from: 50 (3.4×10^6 MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 4-12

Property class: Tensile strength

Material: Shale (e)

Formation: Pierre Shale

Location: -

Condition 1: Intact

Condition 2: -

Condition 3: -

Property/units: Tensile strength (psi)

ranges from: 50 (3.4×10^6 MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Tensile strength

Material: Shales

Formation: -

Location: Various

Condition 1: Various formations, depths, etc.

Condition 2: Represents many samples

Condition 3: -

Property/units: Tensile strength (psi)

ranges from: <100 ($<6.9 \times 10^6$ MPa)

to: 1,538 (1.1×10^9 MPa)

as: -

ranges from: - to: -

Reference: Several refs

Source: Y/OWI/TM36/6 (1978), p. A-7

Property class: Young's modulus

Material: Argillite (a)

Formation: Eleana Argillite

Location: -

Condition 1: Lab measurement

Condition 2: -

Condition 3: -

Property/units: Young's modulus (GPa)

ranges from: 3.7 (3.7×10^9 MPa)

to: 16 (MPa)

as: Confining pressure (MPa)

ranges from: Unconfined to: 20

Reference: -

Source: Proc NEA Workshop OECD (1979b), p. 83

Property class: Young's modulus

Material: Argillite (b)

Formation: Eleana Argillite

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Young's modulus (unconfined) (GPa)

ranges from: 3.74 (3.7×10^9 MPa)

to: -

as: -

ranges from: - to: -

Reference: Y/OWI/TM-36/6 (1978)

Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Young's modulus

Material: Bentonite

Formation: -

Location: -

Condition 1: Density = 2 t/m³

Condition 2: 10% water

Condition 3: -

Property/units: Young's modulus (MPa)

ranges from: 300

to: -

as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 63

Property class: Young's modulus
Material: Bentonite and Sand (a)

Formation: -
Location: Oregon

Condition 1: -
Condition 2: -
Condition 3: -

Property/units: Young's modulus (MPa)

ranges from: ca. 55
to: ca. 80
as: Clay content (wt. %)

ranges from: ca. 10 to: ca. 50

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), Fig. 5

Property class: Young's modulus
Material: Bentonite and Sand (b)

Formation: -
Location: Wyoming
Condition 1: -
Condition 2: -
Condition 3: -

Property/units: Young's modulus (MPa)

ranges from: ca. 45
to: 60
as: Clay content (wt. %)

ranges from: 10 to: 50

Reference: Taylor et al (1980)

Source: RHO-BWI-SA-80 (1981), Fig. 5

Property class: Young's modulus
Material: Clay

Formation: Blue Clay
Location: Italy
Condition 1: -
Condition 2: -
Condition 3: -

Property/units: Young's modulus (elastic modulus) (MPa)

ranges from: 300
to: -
as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Young's modulus

Material: Clay

Formation: Boom Clay
Location: Belgium
Condition 1: -
Condition 2: -
Condition 3: -

Property/units: Young's modulus (elastic modulus) (MPa)

ranges from: 170
to: -
as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Property class: Young's modulus
Material: Oil Shales

Formation: -
Location: -
Condition 1: High grade
Condition 2: -
Condition 3: -

Property/units: Young's modulus (MPa)

ranges from: 7,000 ($7 \times 10(3)$)
to: 17,500 ($1.75 \times 10(4)$)

as: -

ranges from: - to: -

Reference: Netherland et al (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 348

Property class: Young's modulus
Material: Oil Shales

Formation: -
Location: -
Condition 1: Low grade
Condition 2: -
Condition 3: -

Property/units: Young's modulus (MPa)

ranges from: >21,000 ($>2.1 \times 10(4)$)
to: -
as: -

ranges from: - to: -

Reference: Netherland et al (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 348

Property class: Young's modulus

Material: Shale

Formation: Arnheim and Waynesville Fms
Location: Ohio
Condition 1: Ordovician
Condition 2: Intact
Condition 3: -

Property/units: Young's modulus (psi)

ranges from: $1.5 \times 10(6)$ ($1 \times 10(4)$ MPa)
to: -
as: -

ranges from: - to: -

Reference: -

Source: Y/OMI/TM36/6 (1978), p. 5-14

Property class: Young's modulus

Material: Shale

Formation: Chagrin Shale
Location: Ohio
Condition 1: Devonian
Condition 2: Intact
Condition 3: -

Property/units: Young's modulus (psi)

ranges from: $1.7 \times 10(5)$ ($1.2 \times 10(3)$ MPa)
to: -
as: -

ranges from: - to: -

Reference: -

Source: Y/OMI/TM36/6 (1978), p. 4-12

Property class: Young's modulus

Material: Shale

Formation: Hucknall Shale

Location: -

Condition 1: Intact

Condition 2: -

Condition 3: -

Property/units: Young's modulus (elastic

modulus) (psi $\times 10(6)$)

ranges from: 1.48 (1 $\times 10(4)$ MPa)

to: -

as: -

ranges from: - to: -

Reference: Hobbs (1970)

Source: Y/OWI/TM36/6 (1978), p. 6-3

Property class: Young's modulus

Material: Shale

Formation: Pierre Shale

Location: -

Condition 1: Intact

Condition 2: -

Condition 3: -

Property/units: Young's modulus (psi)

ranges from: 1.4 $\times 10(5)$ (9.7 $\times 10(2)$

MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 3-24

Property class: Young's modulus

Material: Shale

Formation: Pierre Shale

Location: Great Plains

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Young's modulus (elastic

modulus) (psi $\times 10(6)$)

ranges from: 0.02 (1.4 $\times 10(2)$ MPa)

to: 0.014 (9.6 $\times 10(1)$ MPa)

as: -

ranges from: - to: -

Reference: Abel and Gentry (1975)

Source: ORNL/Sub/84-64794/1 (1985), p. 293

Property class: Young's modulus

Material: Shale (a)

Formation: -

Location: -

Condition 1: Room temperature

Condition 2: Confining pressure = 0-20 MPa

Condition 3: Brittle-to-ductile transition pressure

Property/units: Young's modulus (MPa)

ranges from: 10

to: 32

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V1 (in preparation) p. 47

Property class: Young's modulus

Material: Shale (b)

Formation: -

Location: -

Condition 1: Room temperature

Condition 2: Confining pressure = <100 MPa

Condition 3: Brittle-to-ductile transition

pressure

Property/units: Young's modulus (MPa)

ranges from: 10

to: 32

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V1 (in preparation) p. 47

Property class: Young's modulus

Material: Shale (c)

Formation: -

Location: -

Condition 1: Intact

Condition 2: -

Condition 3: -

Property/units: Young's modulus (psi)

ranges from: 2 $\times 10(3)$ (1.4 $\times 10(1)$ MPa)

to: 6.4 $\times 10(6)$ (4.4 $\times 10(4)$

MPa)

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Young's modulus

Material: Shale (d)

Formation: -

Location: -

Condition 1: Typical illitic shale

Condition 2: Intact

Condition 3: -

Property/units: Young's modulus (psi)

ranges from: 1.6 $\times 10(6)$ (1.1 $\times 10(4)$

MPa)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Young's modulus

Material: Shales (a)

Formation: -

Location: -

Condition 1: Tested at room temperature

Condition 2: "Dry" specimens

Condition 3: Fifty data points

Property/units: Young's modulus (GPa)

ranges from: 9.9 (9.9 $\times 10(3)$ MPa)

to: 31.7 (3.17 $\times 10(4)$ MPa)

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V3 (in preparation) p. 110

Property class: Young's modulus
Material: Shales (b)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Young's modulus (Pa \times 10(10))

ranges from: 1 (1 \times 10(4) MPa)

to: 500 (5 \times 10(6) MPa)

as: Depth (m)

ranges from: 0 to: 6,000

Reference: Three refs

Source: ORNL-6241/V2 (in preparation) p. 199

Property class: Young's modulus

Material: Shales (c)

Formation: -

Location: Various

Condition 1: Various formations, depths,
etc.

Condition 2: Represents many tests

Condition 3: -

Property/units: Young's modulus (psi)

ranges from: 0,0020 \times 10(6) (1.4 \times 10(1)

MPa)

to: 15.0 \times 10(6) (1 \times 10(5)

MPa)

as: -

ranges from: - to: -

Reference: Fourteen refs

Source: Y/ONI/TM36/6 (1978), p. A-8,9

13.1.5 Appendix A.5. THERMAL PROPERTIES

Property class: Heat capacity

Material: Clay

Formation: Blue Clay

Location: Italy

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Specific heat (J/Kg-K)
(specific heat capacity)

ranges from: $9.21 \times 10(2)$

to: -

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Property class: Heat capacity

Material: Clay

Formation: Boom Clay

Location: Belgium

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Specific heat (J/Kg-K)
(specific heat capacity)

ranges from: $9.21 \times 10(2)$

to: -

as: -

ranges from: - to: -

Reference: -

Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Property class: Heat capacity

Material: Shale

Formation: -

Location: -

Condition 1: Typical illitic shale

Condition 2: Intact

Condition 3: -

Property/units: Heat capacity (BTU/lb-deg F)

ranges from: 0.20 ($8.4 \times 10(2)$ J/Kg-K)

to: -

as: -

ranges from: - to: -

Reference: -

Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Heat capacity

Material: Shale (a)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Heat capacity (J/Kg-K)

ranges from: $5.5 \times 10(2)$

to: $1.042 \times 10(3)$

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V1 (In preparation) p. 40

Property class: Heat capacity

Material: Shale (b)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Heat capacity (J/Kg-K)

ranges from: $7.12 \times 10(2)$

to: $1.170 \times 10(3)$

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V3 (In preparation) p. 345

Property class: Heat capacity

Material: Shale (c)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Specific heat (J/Kg-deg C)

(specific heat capacity)

(J/Kg-K)

ranges from: $7.96 \times 10(2)$

to: -

as: -

ranges from: - to: -

Reference: Loken, M. (personal communication) (1984)

Source: ORNL-6241/V2 (In preparation) p. 99

Property class: Heat capacity

Material: Shales (a)

Formation: -

Location: -

Condition 1: Two tests

Condition 2: -

Condition 3: -

Property/units: Heat capacity (BTU/lb-deg F)

ranges from: 0.16 ($6.7 \times 10(2)$ J/Kg-K)

to: 0.20 ($8.4 \times 10(2)$ J/Kg-K)

as: -

ranges from: - to: -

Reference: Two refs

Source: Y/OWI/TM36/6 (1978), p. A-19

Property class: Heat capacity

Material: Shales (b)

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Specific heat (J/Kg-K)

(specific heat capacity)

(J/Kg-K)

ranges from: $5.50 \times 10(2)$

to: $1.042 \times 10(3)$

as: -

ranges from: - to: -

Reference: -

Source: ORNL-6241/V3 (In preparation) p. 115

Property class: Linear expansion
Material: Argillite
 Formation: Eleana Argillite
 Location: -
 Condition 1: Natural state
 Condition 2: Contracts up to ca. 100 deg C
 Condition 3: Expands from 100 to 500 deg C
Property/units: Coefficient of linear expansion (deg C(-1)) (K(-1))
 ranges from: $8 \times 10(-6)$ to: $15 \times 10(-6)$
 as: -
 ranges from: - to: -
Reference: -
Source: Proc NEA Workshop OECD (1979b), p. 77

Property class: Linear expansion
Material: Shale (a)
 Formation: -
 Location: -
 Condition 1: Intact
 Condition 2: -
 Condition 3: -
Property/units: Coefficient of linear thermal expansion (deg F(-1))
 ranges from: $4 \times 10(-6)$ to: $2.2 \times 10(-6)$
 $K(-1)$
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 2-2

Property class: Linear expansion
Material: Shale (b)
 Formation: -
 Location: -
 Condition 1: Typical illitic shale
 Condition 2: Intact
 Condition 3: -
Property/units: Coefficient of linear thermal expansion (horizontal) (deg F(-1))
 ranges from: $4.5 \times 10(-6)$ to: $2.5 \times 10(-6)$
 $K(-1)$
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Linear expansion
Material: Shale (c)
 Formation: -
 Location: -
 Condition 1: Typical illitic shale
 Condition 2: Intact
 Condition 3: -
Property/units: Coefficient of linear thermal expansion (vertical) (deg F(-1))
 ranges from: $9 \times 10(-6)$ to: $5 \times 10(-6)$
 $K(-1)$
 to: -
 as: -
 ranges from: - to: -
Reference: -
Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Linear expansion
Material: Shales (a)
 Formation: -
 Location: -
 Condition 1: Eight samples
 Condition 2: -
 Condition 3: -
Property/units: Coefficient of linear thermal expansion (K(-1))
 ranges from: $2.5 \times 10(-6)$ to: $15.8 \times 10(-6)$
 as: -
 ranges from: - to: -
Reference: -
Source: ORNL-6241/V3 (in preparation) p. 345

Property class: Linear expansion
Material: Shales (b)
 Formation: -
 Location: -
 Condition 1: Eight data points
 Condition 2: -
 Condition 3: -
Property/units: Coefficient of thermal expansion (K(-1))
 ranges from: $2.9 \times 10(-6)$ to: $12.9 \times 10(-6)$
 as: -
 ranges from: - to: -
Reference: -
Source: ORNL-6241/V1 (in preparation) p. 47

Property class: Thermal conductivity
Material: Argillite (a)
 Formation: Eleana
 Location: -
 Condition 1: At or above 100 deg C
 Condition 2: Parallel to layering
 Condition 3: -
Property/units: Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 ranges from: ca. 1.80 to: -
 as: -
 ranges from: - to: -
Reference: Clark (1966)
Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Thermal conductivity
Material: Argillite (b)
 Formation: Eleana
 Location: -
 Condition 1: At or above 100 deg C
 Condition 2: Perpendicular to layering
 Condition 3: -
Property/units: Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 ranges from: ca. 1.48 to: -
 as: -
 ranges from: - to: -
Reference: McVey et al (1979)
Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Thermal conductivity
 Material: Argillite (c)
 Formation: Eleana Argillite
 Location: Nevada
 Condition 1: Temperature from 25 to 400
 deg C
 Condition 2: Many tests
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.28
 to: 2.7
 as: -
 ranges from: - to: -
 Reference: Two refs
 Source: ORNL-6241/V3 (In preparation) p. 341,
 342

Property class: Thermal conductivity
 Material: Bentonite (a)
 Formation: -
 Location: -
 Condition 1: 90% quartz
 Condition 2: -
 Condition 3: -
 Property/units: Heat conductivity (W/m-deg C)
 (thermal conductivity)
 (W/m-K)
 ranges from: 0.5
 to: 2.0
 as: Water content (%)
 ranges from: 4 to: 20-30
 Reference: -
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 8

Property class: Thermal conductivity
 Material: Bentonite (b)
 Formation: -
 Location: -
 Condition 1: Pressed at 50 to 100 MPa
 Condition 2: Water content ca. 10%
 Condition 3: Density (bulk) = 2.1 t/m(3)
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: ca. 0.75
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 148

Property class: Thermal conductivity
 Material: Bentonite (c)
 Formation: -
 Location: -
 Condition 1: Avoniel or Wyoming
 Condition 2: Mixed with varying amounts of
 sand, crushed granite, etc.
 Condition 3: Ten tests under moist
 conditions
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.7
 to: 3.0
 as: -
 ranges from: - to: -
 Reference: -
 Source: Proc NEA Workshop OECD (1981), p. 342

Property class: Thermal conductivity
 Material: Bentonite (ca)
 Formation: -
 Location: -
 Condition 1: Various pressing forces
 (21-130 MPa)
 Condition 2: Air saturated
 Condition 3: Temperature ca. 25 deg C
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.71
 to: 1.10
 as: Density (g/cm(3))
 ranges from: 1.60 to: 2.13
 Reference: -
 Source: PNL-4452 UC-70 (1983), p. 20

Property class: Thermal conductivity
 Material: Bentonite (d)
 Formation: -
 Location: -
 Condition 1: Avoniel or Wyoming
 Condition 2: Mixed with varying amounts of
 sand, crushed granite, etc.
 Condition 3: Ten tests under dry
 conditions
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.5
 to: 1.0
 as: -
 ranges from: - to: -
 Reference: -
 Source: Proc NEA Workshop OECD (1981), p. 342

Property class: Thermal conductivity
 Material: Bentonite (e)
 Formation: -
 Location: -
 Condition 1: 100% water saturated
 Condition 2: "Compacted"
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.9
 to: 1.3
 as: Temperature (deg C)
 ranges from: "slightly >73" to: -
 Reference: Knutsson (1977)
 Source: ONWI-486 (1983), p. 63

Property class: Thermal conductivity
 Material: Bentonite (f)
 Formation: -
 Location: -
 Condition 1: Density = 1.6-2.0 t/m(3)
 Condition 2: Water content 5-16 %
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 1
 to: 3.5
 as: -
 ranges from: - to: -
 Reference: Roy (1982)
 Source: ONWI-486 (1983), p. 63

Property class: Thermal conductivity
 Material: Bentonite (g)

Formation: -

Location: Wyoming

Condition 1: Constant density

Condition 2: -

Condition 3: -

Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$

ranges from: ca. 0,0

to: ca. 1,2

as: Moisture content (%)

ranges from: ca. 0 to: ca. 20

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 334

Property class: Thermal conductivity
 Material: Bentonite (h)

Formation: -

Location: Wyoming

Condition 1: Density = $2.0\ t/m^3$

Condition 2: 66% water saturation

Condition 3: At 73 deg C

Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$

ranges from: 0,78

to: -

as: -

ranges from: - to: -

Reference: -

Source: ONWI-486 (1983), p. 61

Property class: Thermal conductivity
 Material: Bentonite (Na)

Formation: -

Location: -

Condition 1: Various pressing forces
 $(21-90\ MPa)$

Condition 2: Air saturated

Condition 3: Temperature ca. 25 deg C

Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$

ranges from: 0,52

to: 0,96

as: Density (g/cm^3)

ranges from: 1,70 to: 2,25

Reference: -

Source: PNL-4452 UC-70 (1983), p. 20

Property class: Thermal conductivity
 Material: Bentonite and Crushed Granite (a)

Formation: -

Location: Wyoming

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$

ranges from: 2,7

to: 0,8

as: Clay content (%)

ranges from: ca. 20 to: 100

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 334

Property class: Thermal conductivity
 Material: Bentonite and Crushed Granite (b)

Formation: -

Location: Wyoming

Condition 1: 50% bentonite

Condition 2: Constant density

Condition 3: -

Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$

ranges from: ca. 0,6

to: ca. 1,5

as: Moisture content (%)

ranges from: ca. 0 to: ca. 16

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 334

Property class: Thermal conductivity
 Material: Bentonite and Salt (a)

Formation: -

Location: -

Condition 1: 30:70 bentonite:salt

Condition 2: 10 MPa axial stress

Condition 3: Density (dry) = $1.67-1.71\ t/m^3$

Property/units: Thermal conductivity ($W/m\cdot K$)

ranges from: 1,12

to: 0,99

as: Temperature (deg C)

ranges from: 89 to: 250

Reference: Molecke (1982)

Source: ONWI-486 (1983), p. 53

Property class: Thermal conductivity
 Material: Bentonite and Salt (b)

Formation: -

Location: -

Condition 1: 30:70 bentonite:salt

Condition 2: 10 MPa axial stress

Condition 3: Density (dry) = $1.67-1.71\ t/m^3$

Property/units: Thermal conductivity ($W/m\cdot K$)

ranges from: 1,01

to: 1,12

as: Temperature (deg C)

ranges from: 21 to: 89

Reference: Molecke (1982)

Source: ONWI-486 (1983), p. 53

Property class: Thermal conductivity
 Material: Bentonite and Sand (a)

Formation: -

Location: -

Condition 1: Bentonite:sand from 10:90 to 20:80

Condition 2: Water content 5-30%

Condition 3: -

Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$

ranges from: 0,5

to: 2,0

as: -

ranges from: - to: -

Reference: Fagerstrom and Lundahl (1977)

Source: ONWI-486 (1983), p. 63

Property class: Thermal conductivity
 Material: Bentonite and Sand (b)

Formation: -
 Location: -
 Condition 1: Dry mixtures with sand
 Condition 2: Density (dry) = $1.98-2.12$
 t/m^3
 Condition 3: Temperature range 25 to 300
 deg C

Property/units: Thermal conductivity (W/m-K)
 ranges from: 0.58-0.80
 to: 1.06-1.17
 as: Wt % sand
 ranges from: 0 to: 50
 Reference: Molecke (1982)
 Source: ONWI-486 (1983), p. 53

Property class: Thermal conductivity
 Material: Clay

Formation: -
 Location: S. Paolo mine
 Condition 1: Cubic block, 80-cm edge
 Condition 2: Plio-Pleistocene
 Condition 3: Dominantly illite plus lesser
 smectite, kaolinite and
 chlorite

Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$
 ranges from: 0.014 (1.4 W/m-K)
 to: 0.016 (1.6 W/m-K)
 as: -
 ranges from: - to: -

Reference: -
 Source: ORNL-tr-5110 (1981), p. 12

Property class: Thermal conductivity
 Material: Clay

Formation: Blue Clay
 Location: Italy
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.5
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Rad Waste Management and Nuclear Fuel
 Cycle v. 6 (1985), p. 54

Property class: Thermal conductivity
 Material: Clay

Formation: Oxford Clay
 Location: England
 Condition 1: -
 Condition 2: -
 Condition 3: -

Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.56
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Rad Waste Management and Nuclear Fuel
 Cycle v. 6 (1985), p. 54

Property class: Thermal conductivity
 Material: Clay (a)

Formation: Boom Clay
 Location: Belgium
 Condition 1: At or above 100 deg C
 Condition 2: -
 Condition 3: -

Property/units: Thermal conductivity (matrix)
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$
 ranges from: ca. 0.3
 to: -
 as: -
 ranges from: - to: -

Reference: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Thermal conductivity

Material: Clay (b)
 Formation: Boom Clay
 Location: Belgium
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.5
 to: -
 as: -
 ranges from: - to: -

Reference: Two refs
 Source: Rad Waste Management and Nuclear Fuel
 Cycle v. 6 (1985), p. 54

Property class: Thermal conductivity

Material: Clayey Sandstones
 Formation: -
 Location: -
 Condition 1: 40 to 57 % clay by volume
 Condition 2: 15 to 20% porosity
 Condition 3: -
 Property/units: Heat conductivity
 $(millical/cm\cdot s\cdot deg\ C)$
 $(thermal\ conductivity)$
 ranges from: 2.5 (1.05 W/m-K)
 to: -
 as: -
 ranges from: - to: -

Reference: Zierfuss (1969)
 Source: Y/ONWI-SUB-7009/1 (1976), p. 23

Property class: Thermal conductivity

Material: Hectorite
 Formation: -
 Location: -
 Condition 1: 90% quartz
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 $(W/m\cdot deg\ C)$ $(W/m\cdot K)$
 ranges from: 0.5
 to: 2 to 3
 as: Water content
 ranges from: Dry to: Fully saturated
 Reference: -
 Source: ONWI-312 (1981), p. 18

Property class: Thermal conductivity
 Material: Illite (a)

Formation: -

Location: -

Condition 1: Sealbond

Condition 2: Constant density

Condition 3: -

Property/units: Thermal conductivity
 $(W/m \cdot \text{deg C})$ $(W/m \cdot K)$

ranges from: ca. 0.6

to: ca. 1.6

as: Moisture content (%)

ranges from: ca. 0 to: ca. 10

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 336

Property class: Thermal conductivity
 Material: Illite (b)

Formation: -

Location: -

Condition 1: Sealbond

Condition 2: Mixed with varying amounts of sand, crushed granite, etc.

Condition 3: Four tests under moist conditions

Property/units: Thermal conductivity
 $(W/m \cdot \text{deg C})$ $(W/m \cdot K)$

ranges from: 1.4

to: 4.0

as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 342

Property class: Thermal conductivity
 Material: Illite (c)

Formation: -

Location: -

Condition 1: Sealbond

Condition 2: Mixed with varying amounts of sand, crushed granite, etc.

Condition 3: Four tests under dry conditions

Property/units: Thermal conductivity
 $(W/m \cdot \text{deg C})$ $(W/m \cdot K)$

ranges from: 0.8

to: 1.8

as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 342

Property class: Thermal conductivity
 Material: Illite and Crushed Granite

Formation: -

Location: -

Condition 1: Sealbond

Condition 2: 50% Illite

Condition 3: Constant density

Property/units: Thermal conductivity
 $(W/m \cdot \text{deg C})$ $(W/m \cdot K)$

ranges from: ca. 0.9

to: ca. 1.9

as: Moisture content (%)

ranges from: ca. 0 to: ca. 10

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 336

Property class: Thermal conductivity
 Material: Kaolinite (a)

Formation: -

Location: -

Condition 1: Mixed with varying amounts of sand, crushed granite, etc.

Condition 2: Four tests under moist conditions

Condition 3: -

Property/units: Thermal conductivity
 $(W/m \cdot \text{deg C})$ $(W/m \cdot K)$

ranges from: 1.7

to: 3.5

as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 342

Property class: Thermal conductivity

Material: Kaolinite (b)

Formation: -

Location: -

Condition 1: Mixed with varying amounts of sand, crushed granite, etc.

Condition 2: Four tests under dry conditions

Condition 3: -

Property/units: Thermal conductivity
 $(W/m \cdot \text{deg C})$ $(W/m \cdot K)$

ranges from: 0.9

to: 2.0

as: -

ranges from: - to: -

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 342

Property class: Thermal conductivity

Material: Kaolinite and Crushed Granite

Formation: -

Location: -

Condition 1: -

Condition 2: -

Condition 3: -

Property/units: Thermal conductivity
 $(W/m \cdot \text{deg C})$ $(W/m \cdot K)$

ranges from: 3.4

to: 2.3

as: Clay content (%)

ranges from: ca. 20 to: ca. 50

Reference: -

Source: Proc NEA Workshop OECD (1981), p. 334

Property class: Thermal conductivity

Material: Shale

Formation: -

Location: Kansas

Condition 1: Core 1 and 2

Condition 2: Temperature 20 deg C

Condition 3: -

Property/units: Thermal conductivity $(W/m \cdot K)$

ranges from: 0.7

to: 4.3

as: -

ranges from: - to: -

Reference: Zierfuss (1969)

Source: ORNL-6241/V3 (in preparation) p. 343

<p>Property class: Thermal conductivity Material: Shale Formation: - Location: South Africa Condition 1: Temperature 25 deg C Condition 2: - Condition 3: - Property/units: Thermal conductivity (W/m-K) ranges from: 2.76 to: - as: - ranges from: - to: - Reference: Clark (1941) Source: ORNL-6241/V3 (in preparation) p. 343</p>	<p>Property class: Thermal conductivity Material: Shale (a) Formation: - Location: England Condition 1: Triassic Condition 2: Five tests Condition 3: - Property/units: Thermal conductivity (millical/cm-s-deg C) ranges from: 2.2 (9.2 x 10(-1) W/m-K) to: 5.3 (2.22 W/m-K) as: - ranges from: - to: - Reference: Bullard and Niblett (1951) Source: Y/OMI/SUB-7009/1 (1976), p. 26</p>
<p>Property class: Thermal conductivity Material: Shale Formation: Karoo Shale Location: Orange Free State Condition 1: Temperature 35 deg C Condition 2: - Condition 3: - Property/units: Thermal conductivity (W/m-K) ranges from: 1.97 to: 2.89 as: - ranges from: - to: - Reference: Boch (1971) Source: ORNL-6241/V3 (in preparation) p. 341</p>	<p>Property class: Thermal conductivity Material: Shale (b) Formation: - Location: - Condition 1: Typical lithic shale Condition 2: Intact Condition 3: - Property/units: Thermal conductivity (horizontal) (BTU/hr-ft-deg F) ranges from: 1.1 (1.9 W/m-K) to: - as: - ranges from: - to: - Reference: - Source: Y/OMI/TM36/6 (1978), p. 7-8</p>
<p>Property class: Thermal conductivity Material: Shale Formation: Nonesuch Shale Location: Michigan Condition 1: Temperature 30 deg C Condition 2: - Condition 3: - Property/units: Thermal conductivity (W/m-K) ranges from: 2.64 to: - as: - ranges from: - to: - Reference: Kreig (1983) Source: ORNL-6241/V3 (in preparation) p. 341</p>	<p>Property class: Thermal conductivity Material: Shale (c) Formation: - Location: - Condition 1: - Condition 2: - Condition 3: - Property/units: Thermal conductivity (horizontal) (J/s m-deg C) (W/m-K) ranges from: 1.89 to: - as: - ranges from: - to: - Reference: Loken, M. (personal communication) (1984) Source: ORNL-6241/V2 (in preparation) p. 99</p>
<p>Property class: Thermal conductivity Material: Shale Formation: Pierre Shale Location: - Condition 1: Temperature 0 deg C Condition 2: Two tests Condition 3: - Property/units: Thermal conductivity (W/m-K) ranges from: 1.42 to: 1.94 as: - ranges from: - to: - Reference: Woods Ide (1961) Source: ORNL-6241/V3 (in preparation) p. 341</p>	<p>Property class: Thermal conductivity Material: Shale (d) Formation: - Location: - Condition 1: - Condition 2: - Condition 3: - Property/units: Thermal conductivity (horizontal) (W/m-K) ranges from: 1.52 to: 2.26 as: - ranges from: - to: - Reference: - Source: ORNL-6241/V1 (in preparation) p. 40</p>

Property class: Thermal conductivity
 Material: Shale (e)
 Formation: -
 Location: -
 Condition 1: Typical illitic shale
 Condition 2: Intact
 Condition 3: -
 Property/units: Thermal conductivity
 (vertical) (BTU/hr-ft-deg F)
 ranges from: 0.8 (1.4 W/m-K)
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Property class: Thermal conductivity
 Material: Shale (f)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (vertical) (W/m-K)
 ranges from: 1.21
 to: 1.57
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL-6241/V1 (In preparation) p. 40

Property class: Thermal conductivity
 Material: Shale (g)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity ratio
 (vertical/horizontal)
 ranges from: 0.76
 to: -
 as: -
 ranges from: - to: -
 Reference: Loken, M. (personal communication)
 (1984)
 Source: ORNL-6241/V2 (In preparation) p. 99

Property class: Thermal conductivity
 Material: Shale (h)
 Formation: -
 Location: England
 Condition 1: Carboniferous
 Condition 2: Eleven tests
 Condition 3: -
 Property/units: Thermal conductivity
 (millical/cm-s-deg C)
 ranges from: 3.0 (1.26 W/m-K)
 to: 4.3 (1.80 W/m-K)
 as: -
 ranges from: - to: -
 Reference: Bullard and Niblett (1951)
 Source: Y/OWI/SUB-7009/1 (1976), p. 26

Property class: Thermal conductivity
 Material: Shale (i)
 Formation: -
 Location: England
 Condition 1: Carboniferous
 Condition 2: Temperature 20 deg C
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.26
 to: 1.80
 as: -
 ranges from: - to: -
 Reference: Bach (1971)
 Source: ORNL-6241/V3 (in preparation) p. 341

Property class: Thermal conductivity
 Material: Shale (j)
 Formation: -
 Location: Massachusetts
 Condition 1: Temperature 45 deg C
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.62
 to: -
 as: -
 ranges from: - to: -
 Reference: Eckert (1959)
 Source: ORNL-6241/V3 (in preparation) p. 341

Property class: Thermal conductivity
 Material: Shale (k)
 Formation: -
 Location: Sunderland, MA
 Condition 1: Density (bulk) = 2.67
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (millical/cm-s-deg C)
 ranges from: 3.87 (1.62 W/m-K)
 to: 4.25 (1.78 W/m-K)
 as: Wetting and compression
 ranges from: Dry, uncompressed to: Wet,
 compressed
 Reference: Clark (1941)
 Source: Y/OWI/SUB-7009/1 (1976), p. 28

Property class: Thermal conductivity
 Material: Shale (l)
 Formation: Conasauga Shale
 Location: -
 Condition 1: At or above 100 deg C
 Condition 2: Calcareous
 Condition 3: -
 Property/units: Thermal conductivity (matrix)
 (W/m-deg C) (W/m-K)
 ranges from: 0.7 to 2.1
 to: -
 as: -
 ranges from: - to: -
 Reference: Two refs
 Source: Proc NEA Workshop OECD (1979b), p. 87

Property class: Thermal conductivity
 Material: Shale (m)
 Formation: Conasauga Shale
 Location: -
 Condition 1: Temperature from 66 to 326
 deg C
 Condition 2: Several tests
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 0.715
 to: 2.20
 as: -
 ranges from: - to: -
 Reference: Robertson (1979)
 Source: ORNL-6241/V3 (in preparation) p. 340

Property class: Thermal conductivity
 Material: Shale (n)
 Formation: -
 Location: -
 Condition 1: Typical illite shale
 Condition 2: Temperature 25 deg C
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.38
 to: 1.9
 as: -
 ranges from: - to: -
 Reference: Zerby (1977)
 Source: ORNL-6241/V3 (in preparation) p. 341

Property class: Thermal conductivity
 Material: Shales
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (vertical)
 (W/m-K)
 ranges from: 1.21
 to: 1.57
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL-6241/V3 (in preparation) p. 115

Property class: Thermal conductivity
 Material: Shales
 Formation: -
 Location: -
 Condition 1: Temperature from 0 to 304
 deg C
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 1.47
 to: 2.00
 as: -
 ranges from: - to: -
 Reference: Moss (1981)
 Source: ORNL-6241/V3 (in preparation) p. 340

Property class: Thermal conductivity
 Material: Shales
 Formation: -
 Location: California
 Condition 1: Forty-five tests
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (W/m-K)
 ranges from: 0.99 +/- 0.3
 to: 1.63 +/- 0.3
 as: -
 ranges from: - to: -
 Reference: Thomas (1973)
 Source: ORNL-6241/V3 (in preparation) p. 341

Property class: Thermal conductivity
 Material: Shales (a)
 Formation: -
 Location: -
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (horizontal) (W/m-K)
 ranges from: ca. 1.60
 to: ca. 2.20
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL-6241/V3 (in preparation) p. 117

Property class: Thermal conductivity
 Material: Shales (b)
 Formation: -
 Location: Various
 Condition 1: Various formations, depths,
 etc.
 Condition 2: Represents many tests
 Condition 3: -
 Property/units: Thermal conductivity
 (BTU/ft-hr-deg F)
 ranges from: 0.34 (5.9 x 10(-1) W/m-K)
 to: 1.77 (3.1 W/m-K)
 as: -
 ranges from: - to: -
 Reference: Several refs
 Source: Y/ONI/TM36/6 (1978), p. A-18

Property class: Thermal conductivity
 Material: Silt/Clay Soil (a)
 Formation: -
 Location: -
 Condition 1: Density (bulk) = 1.74 t/m(3)
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.8
 to: 2.0
 as: Water content (%)
 ranges from: 4 to: 15
 Reference: Mitchell (1976)
 Source: ONI-486 (1983), p. 54

Property class: Thermal conductivity
 Material: Silt/Clay Soil (b)
 Formation: -
 Location: -
 Condition 1: Density (bulk) = 1.02 t/m³
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.4
 to: 0.85
 as: Water content (%)
 ranges from: 8 to: 35
 Reference: Mitchell (1976)
 Source: ONWI-486 (1983), p. 54

Property class: Thermal conductivity
 Material: Silt/Clay Soil (c)
 Formation: -
 Location: -
 Condition 1: Density (bulk) = 1.16 t/m³
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.5
 to: 1.1
 as: Water content (%)
 ranges from: 7 to: 40
 Reference: Mitchell (1976)
 Source: ONWI-486 (1983), p. 54

Property class: Thermal conductivity
 Material: Silt/Clay Soil (d)
 Formation: -
 Location: -
 Condition 1: Density (bulk) = 1.31 t/m³
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.6
 to: 1.3
 as: Water content (%)
 ranges from: 6 to: 32
 Reference: Mitchell (1976)
 Source: ONWI-486 (1983), p. 54

Property class: Thermal conductivity
 Material: Silt/Clay Soil (e)
 Formation: -
 Location: -
 Condition 1: Density (bulk) = 1.45 t/m³
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.7
 to: 1.5
 as: Water content (%)
 ranges from: 6 to: 25
 Reference: Mitchell (1976)
 Source: ONWI-486 (1983), p. 54

Property class: Thermal conductivity
 Material: Silt/Clay Soil (f)
 Formation: -
 Location: -
 Condition 1: Density (bulk) = 1.60 t/m³
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity
 (W/m-deg C) (W/m-K)
 ranges from: 0.75
 to: 1.75
 as: Water content (%)
 ranges from: 5 to: 20
 Reference: Mitchell (1976)
 Source: ONWI-486 (1983), p. 54

Property class: Thermal conductivity
 Material: Soils
 Formation: -
 Location: -
 Condition 1: Dry
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (k x
 10(4)) (?)
 ranges from: 3
 to: 5
 as: -
 ranges from: - to: -
 Reference: Smith and Byers (1938)
 Source: Y/ONWI/SUB-7009/1 (1976), p. 19

Property class: Thermal conductivity
 Material: Soils
 Formation: -
 Location: -
 Condition 1: Wetted
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (k x
 10(4)) (?)
 ranges from: 3-4
 to: 8-12
 as: Moisture content
 ranges from: "Dry" to: 100% moisture,
 equivalent
 Reference: Smith (1939)
 Source: Y/ONWI/SUB-7009/1 (1976), p. 19

Property class: Thermal conductivity
 Material: Soils
 Formation: -
 Location: Bristol, VA
 Condition 1: LL x PL = 2180
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (Btu per
 hr-sq ft) (deg F per ft) (?)
 ranges from: 0.14
 to: 0.60
 as: Moisture content (%)
 ranges from: 0 to: 30
 Reference: Carter (1951)
 Source: Y/ONWI/SUB-7009/1 (1976), p. 20

Property class: Thermal conductivity
 Material: Soils
 Formation: -
 Location: Columbus, MS
 Condition 1: LL x PL = 0
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (Btu per hr sq ft) (deg F per ft) (?)
 ranges from: 0.28
 to: 2.28
 as: Moisture content (%)
 ranges from: 0 to: 30
 Reference: Carter (1951)
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Property class: Thermal conductivity
 Material: Soils (a)
 Formation: -
 Location: Cleveland, TN
 Condition 1: LL x PL = 669
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (Btu per hr sq ft) (deg F per ft) (?)
 ranges from: 0.15
 to: 0.94
 as: Moisture content (%)
 ranges from: 0 to: 30
 Reference: Carter (1951)
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Property class: Thermal conductivity
 Material: Soils (b)
 Formation: -
 Location: Murfreesboro, TN
 Condition 1: LL x PL = 1210
 Condition 2: -
 Condition 3: -
 Property/units: Thermal conductivity (Btu per hr sq ft) (deg F per ft) (?)
 ranges from: 0.21
 to: 0.84
 as: Moisture content (%)
 ranges from: 0 to: 30
 Reference: Carter (1951)
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Property class: Thermal diffusivity
 Material: Bentonite (Na)
 Formation: -
 Location: -
 Condition 1: Dry, compacted
 Condition 2: Density (g/cm³) = 2.1
 Condition 3: Average value between 25 and 600 deg C
 Property/units: Thermal diffusivity (cm²/s x 10³)
 ranges from: 3.03 (3.03 x 10⁻⁷ m²/s)
 to: 3.47 (3.47 x 10⁻⁷ m²/s)
 as: -
 ranges from: - to: -
 Reference: -
 Source: PNL-4452 UC-70 (1983), p. 18, 19

Property class: Thermal diffusivity
 Material: Clay
 Formation: -
 Location: S. Paolo mine
 Condition 1: Cubic block, 80 cm edge
 Condition 2: Plio-Pleistocene
 Condition 3: Dominantly illite plus smectite, kaolinite and chlorite
 Property/units: Thermal diffusivity (cm²/h)
 ranges from: 20 (5.56 x 10⁻⁷ m²/s)
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: ORNL-tr-5110 (1981), p. 12

Property class: Thermal diffusivity
 Material: Clay
 Formation: Blue Clay
 Location: Italy
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Thermal diffusivity (m²/s)
 ranges from: 7.8 x 10⁻⁷
 to: -
 as: -
 ranges from: - to: -
 Reference: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Property class: Thermal diffusivity
 Material: Clay
 Formation: Boom Clay
 Location: Belgium
 Condition 1: -
 Condition 2: -
 Condition 3: -
 Property/units: Thermal diffusivity (m²/s)
 ranges from: 8.1 x 10⁻⁷
 to: -
 as: -
 ranges from: - to: -
 Reference: Two refs
 Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Property class: Thermal diffusivity
 Material: Soils
 Formation: -
 Location: Bristol, VA
 Condition 1: LL x PL = 2180
 Condition 2: -
 Condition 3: -
 Property/units: Thermal diffusivity (ft²/hr)
 ranges from: 0.0090 (2.3 x 10⁻⁷ m²/s)
 to: 0.016 (4.13 x 10⁻⁷ m²/s)
 as: Moisture content (%)
 ranges from: 0 to: 30
 Reference: Carter (1951)
 Source: Y/OWI/SUB-7009/1 (1976), p. 21

Property class: Thermal diffusivity
Material: Soils
Formation: -
Location: Columbus, MS
Condition 1: LL x PL = 0
Condition 2: -
Condition 3: -
Property/units: Thermal diffusivity (ft²)
per hr
ranges from: 0.016 (4.13 x 10(-7)
m²/s)
to: 0.046 (1.19 x 10(-7)
m²/s)
as: Moisture content (%)
ranges from: 0 to: 30
Reference: Carter (1951)
Source: Y/OWI/SUB-7009/1 (1976), p. 21

Property class: Thermal diffusivity
Material: Soils (a)
Formation: -
Location: Cleveland, TN
Condition 1: LL x PL = 669
Condition 2: -
Condition 3: -
Property/units: Thermal diffusivity (ft²)
per hr
ranges from: 0.0115 (2.97 x 10(-7)
m²/s)
to: 0.022 (5.68 x 10(-7)
m²/s)
as: Moisture content (%)
ranges from: 0 to: 30
Reference: Carter (1951)
Source: Y/OWI/SUB-7009/1 (1976), p. 21

Property class: Thermal diffusivity
Material: Soils (b)
Formation: -
Location: Murfreesboro, TN
Condition 1: LL x PL = 1210
Condition 2: -
Condition 3: -
Property/units: Thermal diffusivity (ft²)
per hr
ranges from: 0.0145 (3.74 x 10(-7)
m²/s)
to: 0.0235 (6.06 x 10(-7)
m²/s)
as: Moisture content (%)
ranges from: 0 to: 30
Reference: Carter (1951)
Source: Y/OWI/SUB-7009/1 (1976), p. 21

13.2 Appendix B. PROPERTIES

Batch distribution ratio (Rd) (ml/g?)
 Kaolinite (a)
 Georgia
 ranges from: $1.28 \times 10(2)$
 to: $9.22 \times 10(2)$
 Source: PNL-4452 UC-70 (1983), p. 18

Batch distribution ratio (Rd) (ml/g?)
 Kaolinite (b)
 Georgia
 ranges from: $1.88 \times 10(2)$
 to: $9.0 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Batch distribution ratio (Rd) (ml/g?)
 Smectite
 Arizona
 ranges from: $8.15 \times 10(2)$
 to: $2.7 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Batch distribution ratio (Rd) (ml/g?)
 Smectite
 Texas
 ranges from: $1.4 \times 10(3)$
 to: $1.9 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Batch distribution ratio (Rd) (ml/g?)
 Smectite
 Wyoming
 ranges from: $1.0 \times 10(3)$
 to: $2.0 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Diffusivity (m²/s)
 Bentonite
 ranges from: $1.3 \times 10(-10)$
 to: -
 Source: ONWI-312 (1981), p. 14

Ion exchange capacity (meq/100 g)
 Allophane
 ranges from: 70
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Ion exchange capacity (meq/100 g)
 Bentonite (Na) (a)
 Wyoming
 ranges from: 68.6
 to: -
 Source: AECL-7825 (1984), p. 12

Ion exchange capacity (meq/100 g)
 Bentonite (Na) (b)
 Wyoming
 ranges from: 34.3
 to: -
 Source: AECL-7825 (1984), p. 12

Ion exchange capacity (meq/100 g)
 Chlorite (a)
 ranges from: 10-40
 to: -
 Source: ONWI-486 (1983), p. 67

Ion exchange capacity (meq/100 g)
 Chlorite (b)
 to: 40
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Ion exchange capacity (meq/100 g)
 Clay
 Belgium
 ranges from: ca. 20
 to: -
 Source: Proc NEA Workshop OECD (1979a),
 p. 88

Ion exchange capacity (meq/100 g)
 Glauconite
 ranges from: 11
 to: 10
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Ion exchange capacity (meq/100 g)
 Halloysite
 ranges from: 5
 to: 10
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Ion exchange capacity (meq/100 g)
 Illite (a)
 ranges from: 10
 to: 40
 Source: ONWI-486 (1983), p. 67

Ion exchange capacity (meq/100 g)
 Illite (b)
 ranges from: 16
 to: 50
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Ion exchange capacity (meq/100 g)
 Kaolinite (a)
 ranges from: 3
 to: 15
 Source: ONWI-486 (1983), p. 67

Ion exchange capacity (meq/100 g)
 Kaolinite (b)
 ranges from: 2
 to: 15
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Ion exchange capacity (meq/100 g)
 Palygorskite
 ranges from: 20
 to: 30
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Ion exchange capacity (meq/100 g)
 Smectite
 ranges from: 80
 to: 150
 Source: ONWI-486 (1983), p. 67

Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (Log) (ml/g?)
Smectite (Ca)	Kaolinite (Ca)
ranges from: 80	ranges from: ca. 1.3
to: 150	to: ca. (-1)
Source: ORNL-6241/V2 (in preparation)	Source: Proc NEA Workshop OECD (1979a),
p. 152	p. 282
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (Log) (ml/g?)
Smectite (Na)	Kaolinite (Na)
ranges from: 100	ranges from: ca. 2.3
to: 150	to: ca. 1.3
Source: ORNL-6241/V2 (in preparation)	Source: Proc NEA Workshop OECD (1979a),
p. 152	p. 282
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (Log) (ml/g?)
Vermiculite (a)	Kaolinite (Na)
ranges from: 100	ranges from: >2
to: 150	to: <0
Source: ONWI-486 (1983), p. 67	Source: Proc NEA Workshop OECD (1979a),
	p. 282
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (m(3)/kg) (?)
Vermiculite (b)	Illite
ranges from: 100	ranges from: 0.9
to: 150+	to: -
Source: ORNL-6241/V2 (in preparation)	Source: AECL-7812 (1983), p. 25
p. 152	
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (m(3)/kg) (?)
Bentonite	Illite
ranges from: 0.1	ranges from: 0.005
to: 100	to: 0.02
Source: NUREG/CP-0052 (1983), p. 181	Source: AECL-7812 (1983), p. 25
Ion exchange capacity (meq/g) (?)	Sorption coefficient (Kd) (m(3)/kg) (?)
Smectite (Ca)	Illite
ranges from: 93	ranges from: 0.045
to: 12	to: 0.090
Source: ONWI-312 (1981), p. 24	Source: AECL-7825 (1984), p. 25
Ion exchange capacity (meq/g) (?)	Sorption coefficient (Kd) (m(3)/kg) (?)
Smectite (Li)	Kaolinite
ranges from: 56	ranges from: 0.003
to: 20	to: 0.006
Source: ONWI-312 (1981), p. 24	Source: AECL-7812 (1983), p. 25
Ion exchange capacity (meq/g) (?)	Sorption coefficient (Kd) (m(3)/kg) (?)
Smectite (Na)	Kaolinite
ranges from: 95	ranges from: 0.002
to: 68	to: 0.04
Source: ONWI-312 (1981), p. 24	Source: AECL-7812 (1983), p. 25
Sorption coefficient (Kd) (cm(3)/g) (ml/g)	Sorption coefficient (Kd) (m(3)/kg) (?)
Smectite	Kaolinite
ranges from: ca. 188	ranges from: 0.02
to: ca. 200	to: -
Source: NUREG/CP-0052 (1983), p. 186	Source: AECL-7812 (1983), p. 25
Sorption coefficient (Kd) (Log) (ml/g?)	Sorption coefficient (Kd) (m(3)/kg) (?)
Kaolinite (Ca)	Smectite
ranges from: ca. 2.3	ranges from: 0.06
to: ca. 1.5	to: 0.7
Source: Proc NEA Workshop OECD (1979a),	Source: AECL-7812 (1983), p. 25
p. 282	

Sorption coefficient (Kd) (ml(3)/kg) (?)
 Smectite
 ranges from: 0.034
 to: 0.65
 Source: AECL-7812 (1983), p. 25

Sorption coefficient (Kd) (ml(3)/kg) (?)
 Smectite
 ranges from: 0.030
 to: 0.6
 Source: AECL-7812 (1983), p. 25

Sorption coefficient (Kd) (ml/g)
 Argillite
 ranges from: 0
 to: $1 \times 10(5)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Attapulgite
 ranges from: $1 \times 10(-2)$
 to: $2 \times 10(4)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Bentonite (Ca)
 ranges from: $2.5 \times 10(4)$
 to: $1.1 \times 10(5)$
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Ca)
 ranges from: 2.5
 to: 3.2
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Ca)
 ranges from: $1.2 \times 10(3)$
 to: 865
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na)
 ranges from: $5.0 \times 10(3)$
 to: $6.8 \times 10(3)$
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na)
 ranges from: 0.4
 to: 8.6
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na)
 ranges from: $1.1 \times 10(3)$
 to: $1.0 \times 10(3)$
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na)
 ranges from: 0
 to: $4 \times 10(4)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na) (Accofloc-350)
 ranges from: $1.3 \times 10(3)$
 to: $1.1 \times 10(3)$
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na) (Accofloc-350)
 ranges from: 1.2
 to: 0.1
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na) (Accofloc-350)
 ranges from: $1.5 \times 10(3)$
 to: $1.5 \times 10(3)$
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na) (Saline Seal-100)
 ranges from: $2.6 \times 10(3)$
 to: $3.8 \times 10(3)$
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na) (Saline Seal-100)
 ranges from: 2.8
 to: 3.6
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite (Na) (Saline Seal-100)
 ranges from: $1.2 \times 10(3)$
 to: $1.5 \times 10(3)$
 Source: ONWI-312 (1981), p. 35

Sorption coefficient (Kd) (ml/g)
 Bentonite and Quartz
 ranges from: <1
 to: $1 \times 10(4)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Bentonite and Sand
 ranges from: 490
 to: $9.5 \times 10(3)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Clay (Na)
 Belle Fourch
 ranges from: 5.6
 to: $5.7 \times 10(3)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Hectorite
 ranges from: 0.4
 to: $7.2 \times 10(3)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Hectorite and Sand
 ranges from: 400
 to: 1300
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Illite
 ranges from: 0
 to: $3 \times 10(5)$
 Source: ORNL-6241/V2 (in preparation)
 p. 132-133

Sorption coefficient (Kd) (ml/g)
 Kaolinite
 ranges from: 0.1
 to: $1.6 \times 10(3)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Kaolinite
 ranges from: 0
 to: $3 \times 10(5)$
 Source: ORNL-6241/V2 (in preparation)
 p. 132-133

Sorption coefficient (Kd) (ml/g)
 Nontronite
 ranges from: 0
 to: $2.25 \times 10(5)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Shale
 ranges from: 57
 to: 100
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Shale
 ranges from: 200
 to: $1.4 \times 10(4)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Smectite
 ranges from: 0
 to: $4 \times 10(5)$
 Source: ORNL-6241/V2 (in preparation)
 p. 132-133

Sorption coefficient (Kd) (ml/g)
 Smectite
 Arizona
 ranges from: 260
 to: 750
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Smectite
 Texas
 ranges from: 310
 to: 685
 Source: Sci Basis for Waste Management - V (1982), p. 638

Sorption coefficient (Kd) (ml/g)
 Smectite
 Texas
 ranges from: 410
 to: 400
 Source: Sci Basis for Waste Management - V (1982), p. 638

Sorption coefficient (Kd) (ml/g)
 Smectite
 Texas
 ranges from: 310
 to: 370
 Source: Sci Basis for Waste Management - V (1982), p. 638

Sorption coefficient (Kd) (ml/g)
 Smectite
 Wyoming
 ranges from: 170
 to: 200
 Source: Sci Basis for Waste Management - V (1982), p. 638

Sorption coefficient (Kd) (ml/g)
 Smectite (Ca)
 ranges from: 0.4
 to: $1.1 \times 10(4)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Smectite (Na)
 ranges from: 0.2
 to: $1 \times 10(5)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Vermiculite
 ranges from: 47
 to: $1.5 \times 10(3)$
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Vermiculite
 South Carolina
 ranges from: $8.9 \times 10(2)$
 to: $1.01 \times 10(4)$
 Source: Sci Basis for Waste Management - V (1982), p. 638

Sorption coefficient (Kd) (ml/g)
 Vermiculite
 South Carolina
 ranges from: $2 \times 10(3)$
 to: $9.8 \times 10(2)$
 Source: Sci Basis for Waste Management - V (1982), p. 638

Sorption coefficient (Kd) (ml/g)
 Vermiculite and Gibbsite
 ranges from: 77
 to: 1520
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Vermiculite and Shale
 ranges from: 41
 to: 1340
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
 Vermiculite and Smectite
 ranges from: 192
 to: 3800
 Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g)
Vermiculite and Zeolite (various)
ranges from: 130
to: $5.92 \times 10(5)$
Source: ONWI-486 (1983), p. 73

Sorption coefficient (Kd) (ml/g?)
Bentonite
ranges from: 1
to: $2 \times 10(5)$
Source: Proc NEA Workshop OECD (1979a),
p. 304

Sorption coefficient (Kd) (ml/g?)
Clay
Belgium
ranges from: 0.87
to: 6.12
Source: Proc NEA Workshop OECD (1979a),
p. 97

Sorption coefficient (Kd) (ml/g?)
Illite
ranges from: 1
to: $3 \times 10(6)$
Source: Proc NEA Workshop OECD (1979a),
p. 304

Sorption coefficient (Kd) (ml/g?)
Kaolinite
ranges from: 1
to: $2 \times 10(4)$
Source: Proc NEA Workshop OECD (1979a),
p. 304

Sorption coefficient (Kd) (ml/g?)
Vermiculite
ranges from: ca. 40
to: $4 \times 10(4)$
Source: Proc NEA Workshop OECD (1979),
p. 315

Sorption coefficient (Kd) (ml/g?)
Vermiculite
ranges from: 30
to: $4 \times 10(6)$
Source: Proc NEA Workshop OECD (1979a),
p. 304

Sorption coefficient (ml/g)
Smectite
ranges from: 200
to: 2,000
Source: ONWI-312 (1981), p. 13

Density (bulk) (average) (g/cm(3))
 Shale
 Illinois, Indiana and Kentucky
 ranges from: 2.36
 to: 2.53
 Source: ORNL-5703 (1983), p. 76

Density (bulk) (average) (g/cm(3))
 Shales
 New York, Kentucky, Virginia and West
 Virginia
 ranges from: 2.61
 to: 2.68
 Source: ORNL-5703 (1983), p. 37

Density (bulk) (g/cm(3))
 Argillite
 Nevada
 ranges from: 2.44
 to: 2.71
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 406

Density (bulk) (g/cm(3))
 Shale
 Michigan
 ranges from: 2.2
 to: 2.8
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 96

Density (bulk) (g/cm(3))
 Shale
 Ohio
 ranges from: 2.65
 to: -
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 108

Density (bulk) (g/cm(3))
 Shales (a)
 ranges from: 1.6
 to: 2.5
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Density (bulk) (kg/m(3))
 Clay
 Belgium
 ranges from: 2010 (2.010 g/cm(3))
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle, v. 6 (1985), p. 54

Density (bulk) (kg/m(3))
 Clay
 England
 ranges from: 2210 (2.210 g/cm(3))
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle, v. 6 (1985), p. 54

Density (bulk) (kg/m(3))
 Clay
 Italy
 ranges from: 2100 (2.100 g/cm(3))
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle, v. 6 (1985), p. 54

Density (bulk) (presumed g/cm(3))
 Oil Shales
 ranges from: 1.506
 to: 2.37
 Source: Y/OWI/SUB-7009/1 (1976), p. 13

Density (bulk) (presumed g/cm(3))
 Shale (a)
 ranges from: 2.1
 to: 2.5
 Source: Y/OWI/SUB-7009/1 (1976), p. 12

Density (bulk) (presumed g/cm(3))
 Shales
 Black Hills
 ranges from: 1.559
 to: 2.038
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Density (bulk) (presumed g/cm(3))
 Shales
 Eastern Canada
 ranges from: 2.07
 to: 2.68
 Source: Y/OWI/SUB-7009/1 (1976), p. 15

Density (bulk) (presumed g/cm(3))
 Shales
 Oklahoma
 ranges from: 2.1
 to: 2.62
 Source: Y/OWI/SUB-7009/1 (1976), p. 16

Density (bulk) (presumed g/cm(3))
 Shales
 Western Canada
 ranges from: 2.43
 to: 2.71
 Source: Y/OWI/SUB-7009/1 (1976), p. 17

Density (bulk) (presumed g/cm(3))
 Shales (b)
 ranges from: 2.40
 to: 2.43
 Source: Y/OWI/SUB-7009/1 (1976), p. 16

Density (bulk) (rho x t/m(3)) (g/cm(3))
 Bentonite (Na) (c)
 Wyoming
 ranges from: 2.54
 to: 1.08
 Source: KBS TEKNISK RAPPORT 74 (1978),
 p. 4

Density (bulk) (t/m(3)) (g/cm(3))
 Bentonite (a)
 ranges from: ca. 2.1
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 148

Density (bulk) (t/m(3)) (g/cm(3))
 Bentonite (Na) (a)
 ranges from: 1.8
 to: 2.0
 Source: KBS TEKNISK RAPPORT 9 (1977),
 p. 4

Density (bulk) (t/m^3) (g/cm^3) Bentonite (Na) (b) ranges from: 1.4 to: 1.7 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4	Density (g/cm^3) Bentonite (Na) (b) ranges from: <1.8 to: ca. 2.5 Source: PNL-4452 UC-70 (1983), p. 21
Density (dry) (average) (lbs/ft^3) Shale Montana ranges from: 118 ($1.890\ g/cm^3$) to: - Source: Y/OWI/TM36/6, p. 6-1	Density (g/cm^3) Bentonite (Na) and Sand (a) ranges from: <1.9 to: ca. 2.8 Source: PNL-4452 UC-70 (1983), p. 22
Density (dry) (kg/m^3) (?) (g/cm^3) (?) Clay and Sand ranges from: ca. 1.6 to: ca. 2.2 Source: RHO-BWI-SA-80 (1981), p. 6	Density (g/cm^3) Bentonite (Na) and Sand (b) ranges from: <1.9 to: ca. 2.7 Source: PNL-4452 UC-70 (1983), p. 23
Density (dry) ($lb/cu\ ft$) Shale Northern Great Plains ranges from: 95 ($1.522\ g/cm^3$) to: 110 ($1.762\ g/cm^3$) Source: ORNL/Sub/84-64794/1 (1985), p. 293	Density (g/cm^3) Shale (j) Gulf Coast ranges from: 2.1 to: 2.3 Source: Y/OWI/SUB-7009/1 (1976), p. 121
Density (dry) (Mg/m^3) (g/cm^3) Bentonite and Sand ranges from: 1.81 to: 1.4 Source: AECL-7812 (1983), p. 31	Density (grain) (average) (presumed g/cm^3) Clays and Shales Eastern US ranges from: 2.69 to: - Source: Y/OWI/SUB-7009/1 (1976), p. 10
Density (dry) (Mg/m^3) (g/cm^3) Kaolinite ranges from: ca. 1.2 to: ca. 1.5 Source: AECL-7812 (1983), p. 35	Density (grain) (average) (presumed g/cm^3) Shale (b) ranges from: 2.71 to: - Source: Y/OWI/SUB-7009/1 (1976), p. 10
Density (dry) (Mg/m^3) (g/cm^3) Kaolinite and Sand ranges from: 2.05 to: 1.45 Source: AECL-7812 (1983), p. 31	Density (grain) (average) (presumed g/cm^3) Shales Black Hills ranges from: 2.66 to: - Source: Y/OWI/SUB-7009/1 (1976), p. 10
Density (dry) (presumed g/cm^3) Chlorite ranges from: 2.6 to: 2.96 Source: Y/OWI/SUB-7009/1 (1976), p. 9	Density (grain) (average) (presumed g/cm^3) Shales Kansas ranges from: 2.72 to: - Source: Y/OWI/SUB-7009/1 (1976), p. 10
Density (dry) (presumed g/cm^3) Shales ranges from: 1.55 to: 2.55 Source: Y/OWI/SUB-7009/1 (1976), Fig. 1	Density (grain) (average) (presumed g/cm^3) Shales Venezuela ranges from: 2.69 to: - Source: Y/OWI/SUB-7009/1 (1976), p. 10
Density (g/cm^3) Bentonite (Ca) ranges from: <1.7 to: ca. 2.14 Source: PNL-4452 UC-70 (1983), p. 24	Density (kg/m^3) Clay Louisiana ranges from: 1,954 ($1.954\ g/cm^3$) to: - Source: ORNL/Sub/84-64794/1 (1985), p. 173
Density (g/cm^3) Bentonite (Na) (a) ranges from: <1.8 to: 2.28 Source: OMNI-312 (1981), p. 32	

Density (kg/m³)
Shale (a)
ranges from: 2,123 (2.123 g/cm³)
to: 3,003 (3.003 g/cm³)
Source: ORNL-6241/V1 (in preparation)
p. 40

Density (kg/m³)
Shale (b)
ranges from: 2,563 (2.563 g/cm³)
to: -
Source: ORNL-6241/V2 (in preparation)
p. 99

Density (lbs/ft³)
Shales
ranges from: 117 (1.874 g/cm³)
to: 188 (3.011 g/cm³)
Source: Y/OWI/TM36/6, p. A-2, 3 & 4

Density (natural) (presumed g/cm³)
Shales (c)
ranges from: 2,43
to: 2,65
Source: Y/OWI/SUB-7009/1 (1976), p. 18

Density (presumed g/cm³)
Illite
ranges from: 2,65
to: 2,13
Source: Y/OWI/SUB-7009/1 (1976), p. 9

Density (presumed g/cm³)
Illite and Smectite
ranges from: 2,64
to: 1,48
Source: Y/OWI/SUB-7009/1 (1976), p. 9

Density (presumed g/cm³)
Kaolinite
ranges from: 2,60 - 2,68
to: 2,43
Source: Y/OWI/SUB-7009/1 (1976), p. 9

Density (presumed g/cm³)
Shale
California
ranges from: 2.5
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 12

Density (presumed g/cm³)
Shale (c)
ranges from: 2.4
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8

Density (presumed g/cm³)
Shale (d)
ranges from: 2.65
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8

Density (presumed g/cm³)
Shale (e)
ranges from: 2.2
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8

Density (presumed g/cm³)
Shale (f)
ranges from: 2.3
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8

Density (presumed g/cm³)
Shale (g)
ranges from: 2.2
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8

Density (presumed g/cm³)
Shale (h)
ranges from: 2.5
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8

Density (presumed g/cm³)
Shale (i)
ranges from: 2.0
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8

Density (presumed g/cm³)
Shale (k)
Gulf Coast
ranges from: 2.58
to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 12

Density (presumed g/cm³)
Smectite
ranges from: 2.2-2.7
to: 1.77
Source: Y/OWI/SUB-7009/1 (1976), p. 9

Density (specific) (t/m³) (g/cm³)
Bentonite (Na)
Wyoming
ranges from: 2.7
to: -
Source: KBS TEKNISK RAPPORT 74 (1978), p. 3

Density (wet) (average) (pounds/ft³)
Shale
Montana
ranges from: 135 (2.162 g/cm³)
to: -
Source: Y/OWI/TM36/6, p. 6-1

Density (wet) (presumed g/cm³)
Shales
ranges from: 1.98
to: 2.67
Source: Y/OWI/SUB-7009/1 (1976), Fig. 1

Moisture content (%)
Argillite
Nevada
ranges from: 2
to: 4
Source: ORNL/Sub/84-64794/1 (1985), p. 406

Moisture content (%)
 Bentonite and Sand
 ranges from: 13
 to: 22
 Source: AECL-7812 (1983), p. 31

Moisture content (%)
 Kaolinite and Sand
 ranges from: 10
 to: 30
 Source: AECL-7812 (1983), p. 31

Moisture content (%)
 Shale
 New Mexico
 ranges from: 3.7
 to: 6.2
 Source: Y/OWI/TM36/6, p. 8-5

Moisture content (%)
 Shale (e)
 Western USA
 ranges from: 35
 to: 15
 Source: Y/OWI/TM36/6, p. 3-1

Moisture content (%)
 Shales (a)
 ranges from: 1.3
 to: 38
 Source: Y/OWI/TM36/6, p. A-13, 14 & 15

Moisture content (natural) (%)
 Shale
 Ohio
 ranges from: 2
 to: -
 Source: Y/OWI/TM36/6, p. 5-14

Moisture content (natural) (%)
 Shale
 Ohio
 ranges from: 4
 to: -
 Source: Y/OWI/TM36/6, p. 4-12

Moisture content (natural) (%)
 Shale (a)
 ranges from: 0
 to: 38
 Source: Y/OWI/TM36/6, p. 2-2

Moisture content (natural) (%)
 Shale (b)
 ranges from: 1.5
 to: -
 Source: Y/OWI/TM36/6, p. 7-8

Moisture content (natural) (%)
 Shale (c)
 ranges from: 18
 to: -
 Source: Y/OWI/TM36/6, p. 3-24

Moisture content (natural) (%)
 Shale (d)
 Northern Great Plains
 ranges from: 18
 to: 38
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Moisture content (natural) (%)
 Shales
 ranges from: 38
 to: 12
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Moisture content (rock) (%)
 Shale
 New Mexico
 ranges from: 3
 to: 11
 Source: Y/OWI/TM36/6, p. 8-3

Porosity (%)
 Argillite
 Nevada
 ranges from: 8 to 16
 to: 6 to 12
 Source: ORNL/Sub/84-64794/1 (1985), p. 406

Porosity (%)
 Clay
 Belgium
 ranges from: 38.5
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Porosity (%)
 Clay
 England
 ranges from: 30
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Porosity (%)
 Clay
 Italy
 ranges from: 25
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Porosity (%)
 Shale
 ranges from: 33
 to: -
 Source: Y/OWI/TM36/6, p. 3-24

Porosity (%)
 Shale
 Colorado
 ranges from: 4.1
 to: 5.1
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Porosity (%)
 Shale
 Tennessee
 ranges from: 0.5
 to: 1.9
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Porosity (%)
 Shale (a)
 ranges from: 30
 to: 5 to 10
 Source: ORNL-6241/V2 (in preparation)
 p. 218

Porosity (%)
 Shale (a)
 Michigan
 ranges from: 3
 to: 10
 Source: ORNL-5703 (1983), p. 106

Porosity (%)
 Shale (b)
 Illinois, Indiana, Kentucky
 ranges from: 0.95
 to: 4.64
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 85

Porosity (%)
 Shale (b)
 Michigan
 ranges from: 3
 to: 10
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 98

Porosity (%)
 Shales
 ranges from: 0.7 (70% ?)
 to: 0.1 (10% ?)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Porosity (%)
 Shales
 Appalachian Basin
 ranges from: ca. 3
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Porosity (%)
 Shales
 Illinois Basin
 ranges from: 0.9
 to: 4.6
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Porosity (%)
 Shales (a)
 Kentucky
 ranges from: 3.3
 to: 10.1
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Porosity (%)
 Shales (b)
 Kentucky
 ranges from: 15
 to: 3
 Source: Y/OWI/SUB-7009/1 (1976), p. 16

Porosity (%)
 Shales
 Michigan Basin
 ranges from: 3
 to: 10
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Porosity (%)
 Shales
 Oklahoma
 ranges from: 25
 to: 2
 Source: Y/OWI/SUB-7009/1 (1976), p. 16

Porosity (%)
 Shales
 USA and Europe
 ranges from: 19
 to: 1
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Porosity (%)
 Shales (a)
 ranges from: 3
 to: 15
 Source: ORNL-6241/V2 (in preparation)
 p. 218

Porosity (%)
 Shales (b)
 ranges from: 15 to 45
 to: 3 to 20
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Porosity (%)
 Shales (c)
 ranges from: 0.4
 to: 7.2
 Source: Y/OWI/SUB-7009/1 (1976), p. 18

Porosity (%)
 Shales (d)
 ranges from: 0.0
 to: 44.8
 Source: Y/OWI/TM36/6, p. A-12

Porosity (%)
 Shales (e)
 Germany
 ranges from: 25
 to: ca. 0
 Source: Y/OWI/SUB-7009/1 (1976), p. 15

Porosity (average) (vol. %)
 Shale (a)
 Illinois, Indiana and Kentucky
 ranges from: 0.95
 to: 4.64
 Source: ORNL-5703 (1983), p. 76

Porosity (average) (vol. %)

Shales
Kentucky, New York, Virginia and West Virginia
ranges from: 2.86 to 3.87
to: -
Source: ORNL-5703 (1983), p. 37

Porosity (effective) (%)

Shale
Ohio
ranges from: 4
to: -
Source: Y/OWI/TM36/6, p. 5-14

Porosity (effective) (%)

Shales
Pennsylvania
ranges from: 1.17
to: -
Source: ORNL-6241/V2 (In preparation)
p. 219

Porosity (effective) (%)

Shales
South Carolina
ranges from: ca. 0.5
to: -
Source: ORNL-6241/V2 (In preparation)
p. 219

Porosity (effective) (units not stated)

Bentonite and Sand
ranges from: ca. 0.4
to: 0.002
Source: AECL-7812 (1983), p. 32

Porosity (effective) (units not stated)

Illite
ranges from: ca. 0.5
to: ca. 0.002
Source: AECL-7812 (1983), p. 32

Porosity (effective) (units not stated)

Kaolinite
ranges from: ca. 0.5
to: ca. 0.002
Source: AECL-7812 (1983), p. 32

Porosity (effective) (units not stated)

Shale
ranges from: 0.05
to: 0.005
Source: ORNL-6241/V1 (In preparation)
p. 33

Porosity (effective) (units not stated)

Shale
South Carolina
ranges from: 0.005
to: -
Source: ORNL-6241/V2 (In preparation)
p. 52

Porosity (effective) (units not stated)

Shale (a)
ranges from: 0.01
to: -
Source: ORNL-6241/V2 (In preparation)
p. 99

Porosity (primary) (%)

Shale
Ohio
ranges from: >3 %
to: -
Source: ORNL/Sub/84-64794/1 (1985),
p. 108

Porosity (rock mass) (%)

Shale

ranges from: 3.0
to: -
Source: Y/OWI/TM36/6, p. 7-8

Porosity (rock mass) (%)

Shale

Ohio

ranges from: 8
to: -
Source: Y/OWI/TM36/6, p. 4-12

Porosity (rock mass) (%)

Shale (b)

ranges from: 0
to: 45
Source: Y/OWI/TM36/6, p. 2-2

Porosity (total) (units not stated)

Shale

ranges from: 0.1
to: 0.01
Source: ORNL-6241/V1 (In preparation)
p. 33

Porosity (total) (units not stated)

Shale
Great Britain

ranges from: 0.020
to: 0.101
Source: ORNL-6241/V2 (In preparation)
p. 52

Porosity (total) (units not stated)

Shale
Illinois, Indiana, Kentucky

ranges from: 0.009
to: 0.046
Source: ORNL-6241/V2 (In preparation)
p. 52

Porosity (total) (units not stated)

Shale
Kansas

ranges from: 0.073
to: 0.106
Source: ORNL-6241/V2 (In preparation)
p. 52

Porosity (total) (units not stated)

Shale
Kentucky

ranges from: 0.074
to: 0.076
Source: ORNL-6241/V2 (In preparation)
p. 52

Porosity (total) (units not stated)
 Shale
 Michigan
 ranges from: 0.03
 to: 0.10
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale
 Missouri
 ranges from: 0.113
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale
 Michigan
 ranges from: 0.010
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale
 Tennessee
 ranges from: 0.005
 to: 0.019
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale
 Utah
 ranges from: 0.009
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale (a)
 ranges from: 0.03
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 99

Porosity (total) (units not stated)
 Shale (b)
 ranges from: 0.03
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale (c)
 ranges from: 0.003
 to: 0.056
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale (d)
 Ohio
 ranges from: 0.03
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale (e)
 Pennsylvania
 ranges from: 0.0117
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Porosity (total) (units not stated)
 Shale (f)
 Scotland
 ranges from: 0.016
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Specific gravity (dimensionless)
 Bentonite (a)
 ranges from: 2.21
 to: -
 Source: Proc NEA Workshop OECD (1981),
 p. 340

Specific gravity (dimensionless)
 Bentonite (b)
 Black Hills
 ranges from: 2.18
 to: -
 Source: Proc NEA Workshop OECD (1981),
 p. 340

Specific gravity (dimensionless)
 Bentonite (Na)
 Wyoming
 ranges from: 2.66
 to: -
 Source: AECL-7825 (1984), p. 12

Specific gravity (dimensionless)
 Bentonite (Na) and Sand
 Wyoming
 ranges from: 2.635
 to: -
 Source: AECL-7825 (1984), p. 12

Specific gravity (dimensionless)
 Kaolinite
 ranges from: 2.60
 to: -
 Source: Proc NEA Workshop OECD (1981),
 p. 340

Specific gravity (g/cm(3))
 Bentonite (a)
 Oregon
 ranges from: 2.73
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Specific gravity (g/cm(3))
 Bentonite (b)
 Oregon
 ranges from: 2.85
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Specific gravity (g/cm³)
 Bentonite (c)
 Wyoming
 ranges from: 2.77
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Specific gravity (g/cm³)
 Clay
 Hanford
 ranges from: 2.71
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Specific surface (m²)/g)
 Bentonite (Na)
 ranges from: 519
 to: 615
 Source: AECL-7825 (1984), p. 12

Specific surface (m²)/g)
 Bentonite (Na) and Sand
 ranges from: 284
 to: -
 Source: AECL-7825 (1984), p. 12

Specific surface (m²)/g)
 Shale
 Michigan
 ranges from: 0.05
 to: 1.2
 Source: ORNL-5703 (1983), p. 109

Specific surface (m²)/g)
 Smectite
 ranges from: 800
 to: -
 Source: NUREG/CP-0052 (1983), p. 182

Void ratio (dimensionless)
 Clays
 ranges from: ca. 1.5 to 3.0
 to: ca. 0.5 to 0.6
 Source: ONWI-312 (1981), p. 21

Void ratio (dimensionless)
 Kaolinite (Ca)
 ranges from: 2.5
 to: 1.0
 Source: ONWI-486 (1983), p. 38

Void ratio (dimensionless)
 Kaolinite (Na)
 ranges from: 2.5
 to: 1.0
 Source: ONWI-486 (1983), p. 38

Void ratio (dimensionless)
 Smectite (Ca)
 ranges from: 7.0
 to: 1.0
 Source: ONWI-486 (1983), p. 38

Void ratio (dimensionless)
 Smectite (Na)
 ranges from: 30.0
 to: 1.0
 Source: ONWI-486 (1983), p. 38

Water content (average) (%)
 Shale
 Montana
 ranges from: 15
 to: -
 Source: Y/OWI/TM36/6, p. 6-1

Water content (vol %)
 Shales (b)
 ranges from: 70 to 90
 to: 5 to 10
 Source: ORNL-6241/V2 (in preparation)
 p. 218

Groundwater travel distance (m)	Hydraulic conductivity (cm/s)
Shale	Bentonite (Na) and (Ca)
ranges from: 6	Various
to: 40	ranges from: 10(-4)
Source: ORNL-6241/V1 (In preparation)	to: 10(-12)
p. 36	Source: ONWI-486 (1983), p. 36
Hydraulic conductivity (cm/s x 10(12))	Hydraulic conductivity (cm/s)
Bentonite (Na) (a)	Bentonite (Na) and Sand
ranges from: <1 (<1 x 10(-12) cm/s)	ranges from: ca. 10(-9)
to: ca. 8, (ca. 8 x 10(-12) cm/s)	to: ca. 10(-12)
Source: ONWI-312 (1981), p. 11	Source: PNL-4452 UC-70 (1983), p. 16
Hydraulic conductivity (cm/s)	Hydraulic conductivity (cm/s)
Bentonite (Ca)	Clay
ranges from: $1.3 \times 10(-12)$ and $1.6 \times 10(-12)$	ranges from: $7 \times 10(-12)$
to:	to: $2 \times 10(-12)$
Source: ONWI-312 (1981), p. 33	Source: PNL-4452 UC-70 (1983), p. 14
Hydraulic conductivity (cm/s)	Hydraulic conductivity (cm/s)
Bentonite (Na)	Clay
ranges from: $2.7 \times 10(-9)$	Louisiana
to: $0.7 \times 10(-9)$	ranges from: $10(-8)$ (est)
Source: ONWI-312 (1981), p. 34	to:
Source: ONWI-486 (1983), p. 61	Source: ORNL/Sub/84-64794/1 (1985), p. 175
Hydraulic conductivity (cm/s)	Hydraulic conductivity (cm/s)
Bentonite (Na)	Illite (Ca)
Wyoming	ranges from: $10(-10)$
ranges from: Not stated	to: $10(-6)$
to: $10(-9)$	Source: ONWI-486 (1983), p. 35
Source: ONWI-486 (1983), p. 61	Hydraulic conductivity (cm/s)
Hydraulic conductivity (cm/s)	Illite (Na)
Bentonite (Na) (b)	ranges from: $10(-10)$
ranges from: ca. $1 \times 10(-13)$	to: $10(-7)$
to:	Source: ONWI-486 (1983), p. 35
Source: ONWI-312 (1981), p. 10	Hydraulic conductivity (cm/s)
Hydraulic conductivity (cm/s)	Kaolinite (Ca)
Bentonite (Na) (c)	ranges from: $10(-8)$
ranges from: $4.6 \times 10(-12)$ and $6.4 \times 10(-12)$	to: $10(-5)$
to:	Source: ONWI-486 (1983), p. 35
Source: ONWI-312 (1981), p. 33	Hydraulic conductivity (cm/s)
Hydraulic conductivity (cm/s)	Kaolinite (Na)
Bentonite (Na) (d)	ranges from: $10(-8)$
ranges from: $6.6 \times 10(-10)$	to: $10(-5)$
to:	Source: ONWI-486 (1983), p. 35
Source: ONWI-312 (1981), p. 33	Hydraulic conductivity (cm/s)
Hydraulic conductivity (cm/s)	Shale
Bentonite (Na) (e)	Illinoian Basin
ranges from: $5.6 \times 10(-13)$	ranges from: $10(-9)$
to:	to:
Source: ONWI-312 (1981), p. 33	Source: ORNL-6241/V2 (In preparation)
Hydraulic conductivity (cm/s)	p. 220
Bentonite (Na) (f)	Hydraulic conductivity (cm/s)
ranges from: $6 \times 10(-12)$	Shale
to: $6 \times 10(-13)$	Tennessee
Source: PNL-4452 UC-70 (1983), p. 13	ranges from: $6 \times 10(-10)$
Hydraulic conductivity (cm/s)	to: $3 \times 10(-11)$
Bentonite (Na) (g)	Source: ORNL-6241/V2 (In preparation)
ranges from: $1.2 \times 10(-12)$	p. 220
to: $8.3 \times 10(-13)$	
Source: PNL-4452 UC-70 (1983), p. 27	

Hydraulic conductivity (cm/s)

Shales

East Coast

 ranges from: 10^{-7} to: 10^{-11}

 Source: ORNL-6241/V2 (in preparation) p. 220

Hydraulic conductivity (cm/s)

Shales

Michigan and Appalachian Basins

 ranges from: 10^{-6} to: 10^{-9}

 Source: ORNL-6241/V2 (in preparation) p. 220

Hydraulic conductivity (cm/s)

Shales

Northern Great Plains

 ranges from: 10^{-6} to: 10^{-10}

 Source: ORNL-6241/V2 (in preparation) p. 220

Hydraulic conductivity (cm/s)

Shales

 ranges from: 10^{-8} to: 10^{-11}

 Source: ORNL-6241/V2 (in preparation) p. 218

Hydraulic conductivity (cm/s)

Shales (d)

 ranges from: 10^{-9} to: 10^{-11}

 Source: ORNL-6241/V2 (in preparation) p. 219

Hydraulic conductivity (cm/s)

Silty Clay

 ranges from: 5×10^{-6} to: ca. 2×10^{-8}

 Source: ONWI-486 (1983), p. 39

Hydraulic conductivity (cm/s)

Silky Clay

 ranges from: 5×10^{-6} to: 10^{-7}

 Source: ONWI-486 (1983), p. 39

Hydraulic conductivity (cm/s)

Smectite (Ca) (a)

 ranges from: 10^{-11} to: 10^{-6}

 Source: ONWI-486 (1983), p. 35

Hydraulic conductivity (cm/s)

Smectite (Na) (a)

 ranges from: 10^{-11} to: 10^{-7}

 Source: ONWI-486 (1983), p. 35

Hydraulic conductivity (cm/s)

Volclay saline seal and Sand

 ranges from: 2.9×10^{-12} to: 4.1×10^{-12}

 Source: ONWI-312 (1981), p. 33

Hydraulic conductivity (horizontal) (m/s)

Shale

 ranges from: 1×10^{-10} to: 1×10^{-12}

 Source: ORNL-6241/V1 (in preparation) p. 33

Hydraulic conductivity (horizontal) (m/s)

Shale

Illinois

 ranges from: 2×10^{-11} to:

 Source: ORNL-6241/V2 (in preparation) p. 42

Hydraulic conductivity (horizontal) (m/s)

Shale

Maryland

 ranges from: $0.0(?)$ to: 1×10^{-9}

 Source: ORNL-6241/V2 (in preparation) p. 43

Hydraulic conductivity (horizontal) (m/s)

Shale

Michigan

 ranges from: 1×10^{-11} to: 2×10^{-8}

 Source: ORNL-6241/V2 (in preparation) p. 42

Hydraulic conductivity (horizontal) (m/s)

Shale

Pennsylvania

 ranges from: 3×10^{-11} to:

 Source: ORNL-6241/V2 (in preparation) p. 42

Hydraulic conductivity (horizontal) (m/s)

Shale

Pennsylvania

 ranges from: 1×10^{-11} to:

 Source: ORNL-6241/V2 (in preparation) p. 43

Hydraulic conductivity (horizontal) (m/s)

Shale

South Carolina

 ranges from: 1×10^{-13} to: 1×10^{-10}

 Source: ORNL-6241/V2 (in preparation) p. 42

Hydraulic conductivity (horizontal) (m/s)

Shale

South Carolina

 ranges from: 1×10^{-12} to:

 Source: ORNL-6241/V2 (in preparation) p. 43

Hydraulic conductivity (horizontal) (m/s)

Shale

South Dakota

 ranges from: 1×10^{-12} to: 1×10^{-11}

 Source: ORNL-6241/V2 (in preparation) p. 43

Hydraulic conductivity (horizontal) (m/s)	Hydraulic conductivity (m/s)
Shale	Clay
Tennessee	Italy
ranges from: $3 \times 10(-13)$ (3 $\times 10(-11)$ cm/s)	ranges from: $10(-11)$ (1 $\times 10(-9)$ cm/s)
to: $2 \times 10(-12)$ (2 $\times 10(-10)$ cm/s)	to:
Source: ORNL-6241/V2 (in preparation)	Source: Rad Waste Management and Nuclear
p. 42	Fuel Cycle v. 6 (1985), p. 54
Hydraulic conductivity (horizontal) (m/s)	Hydraulic conductivity (vertical) (m/s)
Shale (a)	Shale
ranges from: $1 \times 10(-11)$ (1 $\times 10(-9)$ cm/s)	ranges from: $1 \times 10(-11)$ (1 $\times 10(-9)$ cm/s)
to:	to: $1 \times 10(-13)$ (1 $\times 10(-11)$ cm/s)
Source: ORNL-6241/V2 (in preparation)	Source: ORNL-6241/V1 (in preparation)
p. 99	p. 33
Hydraulic conductivity (horizontal) (m/s)	Hydraulic conductivity (vertical) (m/s)
Shale (b)	Shale
ranges from: $1 \times 10(-16)$ (1 $\times 10(-14)$ cm/s)	ranges from: $1 \times 10(-12)$ (1 $\times 10(-10)$ cm/s)
to: $1 \times 10(-11)$ (1 $\times 10(-9)$ cm/s)	to:
Source: ORNL-6241/V2 (in preparation)	Source: ORNL-6241/V2 (in preparation)
p. 42	p. 99
Hydraulic conductivity (horizontal) (m/s)	Inflow (ml/min per m)
Shale (c)	Shale
ranges from: $1 \times 10(-11)$ (1 $\times 10(-9)$ cm/s)	ranges from: $1 \times 10(-1)$
to: $7 \times 10(-9)$ (7 $\times 10(-7)$ cm/s)	to: $5 \times 10(-1)$
Source: ORNL-6241/V2 (in preparation)	Source: ORNL-6241/V1 (in preparation)
p. 42	p. 38
Hydraulic conductivity (horizontal) (m/s)	Inflow (ml/min per m)
Shale (d)	Shale
ranges from: $1 \times 10(-11)$ (1 $\times 10(-9)$ cm/s)	ranges from: 10
to: $1 \times 10(-6)$ (1 $\times 10(-4)$ cm/s)	to: <1
Source: ORNL-6241/V2 (in preparation)	Source: ORNL-6241/V2 (in preparation)
p. 43	p. 106
Hydraulic conductivity (horizontal) (m/s)	Permeability (cm/s) (hydraulic conductivity)
Siltstone/Mudstone	Bentonite (Na) (h)
South Carolina	ranges from: $1 \times 10(-11)$
ranges from: $1 \times 10(-13)$ (1 $\times 10(-11)$ cm/s)	to:
to: $5 \times 10(-10)$ (5 $\times 10(-8)$ cm/s)	Source: ORNL-312 (1981), p. 10
Source: ORNL-6241/V2 (in preparation)	
p. 43	
Hydraulic conductivity (m/s)	Permeability (cm/s) (hydraulic conductivity)
Bentonite and Sand	Bentonite (Na) (l)
ranges from: ca. $10(-6)$ (ca. $1 \times 10(-4)$ cm/s)	ranges from: $3 \times 10(-8)$
to: ca. $10(-14)$ (ca. $1 \times 10(-12)$ cm/s)	to: $1.5 \times 10(-9)$
Source: AECL-7812 (1983), p. 29	Source: ORNL-312 (1981), p. 10
Hydraulic conductivity (m/s)	Permeability (cm/s) (hydraulic conductivity)
Clay	Bentonite and Sand (a)
Belgium	Oregon
ranges from: $10(-10)$ (1 $\times 10(-8)$ cm/s)	ranges from: $9.5 \times 10(-8)$
to: $10(-12)$ (1 $\times 10(-10)$ cm/s)	to:
Source: Rad Waste Management and Nuclear	Source: RHO-BWI-SA-80 (1981), p. 7
Fuel Cycle v. 6 (1985), p. 54	
Hydraulic conductivity (m/s)	Permeability (cm/s) (hydraulic conductivity)
Clay	Bentonite and Sand (b)
England	Oregon
ranges from: $10(-12)$ (1 $\times 10(-10)$ cm/s)	ranges from: < $9.5 \times 10(-8)$
to:	to:
Source: Rad Waste Management and Nuclear	Source: RHO-BWI-SA-80 (1981), p. 7
Fuel Cycle v. 6 (1985), p. 54	

Permeability (cm/s) (hydraulic conductivity)	Permeability (m ²)
Bentonite and Sand (d)	Bentonite (Ca) and (Na)
Wyoming	ranges from: $1 \times 10(-16)$ (9.7 x 10 ⁻⁸ cm/s)
ranges from: $< 9.5 \times 10(-8)$	to:
to:	Source: NUREG/CP-0052 (1983), p. 209
Source: RHO-BWI-SA-80 (1981), p. 7	
Permeability (cm/s) (hydraulic conductivity)	Permeability (m ²)
Clay and Sand	Bentonite and Sand (e)
Hanford	Wyoming
ranges from: $< 9.5 \times 10(-8)$	ranges from: $3 \times 10(-18)$ (2.9 x 10 ⁻⁹ cm/s)
to:	to:
Source: RHO-BWI-SA-80 (1981), p. 7	Source: NUREG/CP-0052 (1983), p. 220
Permeability (cm/s) (hydraulic conductivity)	Permeability (m ²)
Shale (b)	Bentonite and Sand (f)
Great Plains	Wyoming
ranges from: $1 \times 10(-5)$	ranges from: $8 \times 10(-18)$ (7.8 x 10 ⁻⁹ cm/s)
to: $1 \times 10(-10)$	to:
Source: ORNL/Sub/84-64794/1 (1985), p. 293	Source: NUREG/CP-0052 (1983), p. 220
Permeability (ft/yr) (hydraulic conductivity)	Permeability (m ²)
Shale	Kaolinite (a)
Ohio	ranges from: $1 \times 10(-16)$ (9.7 x 10 ⁻⁸ cm/s)
ranges from: $10(-3)$ (9.7 x 10 ⁻¹⁰ cm/s)	to:
to: $10(-4)$ (9.7 x 10 ⁻¹¹ cm/s)	Source: NUREG/CP-0052 (1983), p. 209
Source: Y/OWI/TM36/6 (1978), p. 5-14	
Permeability (ft/yr) (hydraulic conductivity)	Permeability (m ²)
Shale (a)	Kaolinite (b)
ranges from: 0.1 (9.7 x 10 ⁻⁸ cm/s)	ranges from: $5 \times 10(-17)$ (4.9 x 10 ⁻⁸ cm/s)
to: 0.05 (4.8 x 10 ⁻⁸ cm/s)	to:
Source: Y/OWI/TM36/6 (1978), p. 7-8	Source: NUREG/CP-0052 (1983), p. 209
Permeability (ft/yr) (hydraulic conductivity)	Permeability (m ²)
Shales (f)	Kaolinite and Sand
Various	ranges from: $2 \times 10(-16)$ (1.9 x 10 ⁻⁷ cm/s)
ranges from: $1.0 \times 10(-4)$ (9.7 x 10 ⁻¹¹ cm/s)	to:
to: $1.1 \times 10(3)$ (1.1 x 10 ⁻⁴ cm/s)	Source: NUREG/CP-0052 (1983), p. 209
Source: Y/OWI/TM36/6 (1978), p. A-16	
Permeability (horizontal) (ft/yr) (hydraulic conductivity)	Permeability (m ²)
Shale	Shales (e)
ranges from: 0.01 (9.7 x 10 ⁻⁹ cm/s)	ranges from: $10(-17)$ (9.7 x 10 ⁻⁹ cm/s)
to:	to: $10(-21)$ (9.7 x 10 ⁻¹³ cm/s)
Source: Y/OWI/TM36/6 (1978), p. 3-24	Source: ORNL-6241/V2 (in preparation) p. 199
Permeability (horizontal) (ft/yr) (hydraulic conductivity)	Permeability (m ²)
Shale	Smectite (Ca) (b)
Ohio	ranges from: $3 \times 10(-18)$ (2.9 x 10 ⁻⁹ cm/s)
ranges from: 0.1 (9.7 x 10 ⁻⁸ cm/s)	to:
to:	Source: NUREG/CP-0052 (1983), p. 209
Source: Y/OWI/TM36/6 (1978), p. 4-12	
Permeability (horizontal) (ft/yr) (hydraulic conductivity)	Permeability (m ²)
Shale (e)	Smectite (Ca) and Sand
ranges from: $1 \times 10(-4)$ (9.7 x 10 ⁻¹¹ cm/s)	ranges from: $4 \times 10(-17)$ (3.9 x 10 ⁻⁸ cm/s)
to: $1 \times 10(3)$ (9.7 x 10 ⁻⁴ cm/s)	to:
Source: Y/OWI/TM36/6 (1978), p. 2-2	Source: NUREG/CP-0052 (1983), p. 209

Permeability (m(2))
 Smectite (Na) and Sand
 ranges from: $5 \times 10(-19)$ ($4.9 \times 10(-10)$ cm/s)
 to:
 Source: NUREG/CP-0052 (1983), p. 209

Permeability (m/s) (hydraulic conductivity)
 Bentonite (Ca)
 ranges from: $1 \times 10(-9)$ ($1 \times 10(-7)$ cm/s)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Permeability (m/s) (hydraulic conductivity)
 Bentonite (Na) (j)
 ranges from: $5 \times 10(-15)$ ($5 \times 10(-13)$ cm/s)
 to: $1 \times 10(-11)$ ($1 \times 10(-9)$ cm/s)
 Source: KBS TEKNISK RAPPORT 74 (1978), p. 8

Permeability (m/s) (hydraulic conductivity)
 Bentonite (Na) (k)
 ranges from: ca. $1 \times 10(-11)$ (ca. $1 \times 10(-9)$ cm/s)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Permeability (m/s) (hydraulic conductivity)
 Bentonite (Na) (l)
 ranges from: ca. $3 \times 10(-11)$ (ca. $3 \times 10(-9)$ cm/s)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Permeability (m/s) (hydraulic conductivity)
 Bentonite (Na) (m)
 ranges from: $1 \times 10(-10)$ ($1 \times 10(-8)$ cm/s)
 (maximum)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 5

Permeability (md)
 Clays and Shales
 ranges from: $8 \times 10(-4)$ ($7.7 \times 10(-10)$ cm/s)
 to: $2 \times 10(-6)$ ($1.9 \times 10(-12)$ cm/s)
 Source: Proc NEA Workshop OECD (1979b), p. 69

Permeability (md)
 Shale
 ranges from: $5 \times 10(-2)$ ($4.9 \times 10(-7)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shale
 California
 ranges from: $4 \times 10(-4)$ ($3.8 \times 10(-10)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shale
 Colorado
 ranges from: < 0.05 ($< 4.9 \times 10(-7)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Permeability (md)
 Shale
 Gulf Coast
 ranges from: $1 \times 10(-8)$ ($9.6 \times 10(-15)$ cm/s) (?)
 to: $2.5 \times 10(-9)$ ($2.4 \times 10(-15)$ cm/s) (?)
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shale
 Michigan
 ranges from: 0.001 ($1 \times 10(-9)$ cm/s)
 to: 2.0 ($1.9 \times 10(-6)$ cm/s)
 Source: ORNL/5703 (1983), p. 109

Permeability (md)
 Shale
 Michigan
 ranges from: 0.001 ($1 \times 10(-9)$ cm/s)
 to: 2.0 ($1.9 \times 10(-6)$ cm/s)
 Source: ORNL/Sub/84-64794/1 (1985), p. 98

Permeability (md)
 Shale (a)
 ranges from: $1.1 \times 10(-4)$ ($1.1 \times 10(-10)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shales
 ranges from: $8 \times 10(-4)$ ($7.7 \times 10(-10)$ cm/s)
 to: $2 \times 10(-6)$ ($1.9 \times 10(-12)$ cm/s)
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shales
 Illinois
 ranges from: $2 \times 10(-6)$ ($1.9 \times 10(-12)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shales
 Montana
 ranges from: $6 \times 10(-4)$ ($5.8 \times 10(-10)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shales
 New Mexico
 ranges from: $2 \times 10(-6)$ ($1.9 \times 10(-12)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shales
 Oklahoma
 ranges from: $8 \times 10(-4)$ ($7.7 \times 10(-10)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shales
 Texas
 ranges from: $3 \times 10(-4)$ ($2.9 \times 10(-10)$ cm/s)
 to: $7 \times 10(-6)$ ($6.7 \times 10(-12)$ cm/s)
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (md)
 Shales
 Utah
 ranges from: $7 \times 10(-6)$ ($6.7 \times 10(-12)$ cm/s)
 to:
 Source: Y/OWI/SUB-7009/1 (1976), p. 11

Permeability (microdarcies)
 Shale (b)
 ranges from: 100 ($1 \times 10(-7)$ cm/s)
 to: 0.01 ($1 \times 10(-9)$ cm/s)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Permeability (vertical) (factor of K horizontal)
 Shale
 ranges from: $1/2K_h$
 to: $1/10K_h$
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Permeability (vertical) (ft/yr) (hydraulic conductivity)
 Shale
 ranges from: 0.005 ($5 \times 10(-9)$ cm/s)
 to:
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Permeability (vertical) (ft/yr) (hydraulic conductivity)
 Shale
 Ohio
 ranges from: 0.05 ($5 \times 10(-8)$ cm/s)
 to:
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Specific storage (l/m)
 Shale
 ranges from: $1 \times 10(-6)$
 to:
 Source: ORNL-6241/V2 (in preparation)
 p. 99

Specific storage (l/m)
 Shale
 ranges from: $4.3 \times 10(-7)$
 to: $2.8 \times 10(-6)$
 Source: ORNL-6241/V2 (in preparation)
 p. 57

Specific storage (m(-1)) (?)
 Shale
 ranges from: $5 \times 10(-6)$
 to: $5 \times 10(-7)$
 Source: ORNL-6241/V1 (in preparation)
 p. 33

Travel time (years)
 Shale
 ranges from: $>100,000$
 to: $>100,000$
 Source: ORNL-6241/V1 (in preparation)
 p. 36

Bulk modulus (confined) (GPa)
Argillite
 ranges from: 14.0 ($1.4 \times 10(4)$ MPa)
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Bulk modulus (Pa $\times 10(10)$)
Shales
 ranges from: ca. 50 (ca. $5 \times 10(5)$ MPa)
 to: ca. 200 (ca. $2 \times 10(6)$ MPa)
 Source: ORNL-6241/V2 (In preparation)
 p. 199

Bulk modulus (psi)
Shale
 ranges from: $7.6 \times 10(5)$ ($5.2 \times 10(3)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Bulk modulus (psi)
Shale
 ranges from: $77.8 \times 10(3)$ ($5.4 \times 10(2)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Bulk modulus (psi)
Shale
Ohio
 ranges from: $6.3 \times 10(5)$ ($4.3 \times 10(3)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Bulk modulus (psi)
Shale
Ohio
 ranges from: $1.1 \times 10(5)$ ($7.6 \times 10(2)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Cohesion (MPa)
Clay
Belgium
 ranges from: $1 \times 10(-1)$
 to: 1
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Cohesion (MPa)
Clay
Italy
 ranges from: $1 \times 10(-1)$
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Cohesion (psi)
Shale
Ohio
 ranges from: 5,900 ($4.1 \times 10(1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Cohesion (psi)
Shale
Ohio
 ranges from: 14 ($1 \times 10(-1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Cohesion (psi)
Shale (a)
 ranges from: 0 (0 MPa)
 to: 4,250 ($3 \times 10(1)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Cohesion (psi)
Shale (b)
 ranges from: $6 \times 10(3)$ ($4.1 \times 10(1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Cohesion (psi)
Shale (c)
 ranges from: 206 (1.4 MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Cohesion (psi)
Shale (d)
Great Plains
 ranges from: 2 ($1.4 \times 10(-2)$ MPa)
 to: 30 ($2.1 \times 10(-1)$ MPa)
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Cohesion (unconfined) (MPa)
Argillite
 ranges from: $8 \times 10(-1)$
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Compressive strength (kg/cm²)
Shale (a)
Montana
 ranges from: 122 ($1.2 \times 10(1)$ MPa)
 to: 25 (2.5 MPa)
 Source: Y/OWI/TM36/6 (1978), p. 6-13

Compressive strength (kg/cm²)
Shale (b)
Montana
 ranges from: 25 (2.5 MPa)
 to: 55 (5.4 MPa)
 Source: Y/OWI/TM36/6 (1978), p. 6-13

Compressive strength (MPa)
Oil Shales
 ranges from: 35
 to: 138
 Source: ORNL/Sub/84-64794/1 (1985), p. 348

Compressive strength (MPa)
Oil Shales
 ranges from: 138
 to: 172
 Source: ORNL/Sub/84-64794/1 (1985), p. 348

Compressive strength (MPa)
Shale
Indiana
 ranges from: 11
 to: 115
 Source: ORNL/Sub/84-64794/1 (1985), p. 60

Compressive strength (MPa)
 Shales
 Western Ohio
 ranges from: 20
 to: 32
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 71

Compressive strength (psi)
 Shale
 ranges from: $8.5 \times 10(3)$ ($5.9 \times 10(1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 6-3

Compressive strength (psi)
 Shale
 New Mexico
 ranges from: 1,000 (6.9 MPa)
 to: 6,000 ($4.1 \times 10(1)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. 8-5

Compressive strength (psi)
 Shale
 New Mexico
 ranges from: 1,000 (6.9 MPa)
 to: 8,000 ($5.5 \times 10(1)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. 8-2

Compressive strength (psi)
 Shale (b)
 Great Plains
 ranges from: 70 ($4.8 \times 10(-1)$ MPa)
 to: 2,530 ($1.7 \times 10(1)$ MPa)
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Compressive strength (psi)
 Smectite (Na), Kaolinite, Sand Mixtures
 (a)
 Osage, NY
 ranges from: 76.5 ($5.3 \times 10(-1)$ MPa)
 to: 541.0 (3.7 MPa)
 Source: ONWI-312 (1981), p. 24

Compressive strength (psi)
 Smectite (Na), Kaolinite, Sand Mixtures
 (b)
 Osage, NY
 ranges from: 9.1 ($6.3 \times 10(-2)$ MPa)
 to: 85.5 ($5.9 \times 10(-1)$ MPa)
 Source: ONWI-312 (1981), p. 24

Compressive strength (unconfined) (MPa)
 Argillite
 ranges from: 4.75
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 87

Compressive strength (unconfined) (MPa)
 Bentonite and Sand (a)
 Oregon
 ranges from: ca. 0
 to: ca. 1.8
 Source: RHO-BWI-SA-80 (1981), Fig. 4

Compressive strength (unconfined) (MPa)
 Bentonite and Sand (b)
 Wyoming
 ranges from: ca. 0
 to: ca. 3
 Source: RHO-BWI-SA-80 (1981), Fig. 4

Compressive strength (unconfined) (MPa)
 Shales (a)
 ranges from: 25.2
 to: 113.6
 Source: ORNL-6241/V3 (In preparation)
 p. 110

Compressive strength (unconfined) (psi)
 Bentonite (Na) (a)
 ranges from: 55.5 ($3.8 \times 10(-1)$ MPa)
 to: -
 Source: ONWI-312 (1981), p. 22

Compressive strength (unconfined) (psi)
 Kaolinite
 ranges from: 100.3 ($6.9 \times 10(-1)$ MPa)
 to: -
 Source: ONWI-312 (1981), p. 22

Compressive strength (unconfined) (psi)
 Shales (b)
 Various
 ranges from: <100 ($<6.9 \times 10(-1)$ MPa)
 to: $3.7 \times 10(4)$ ($2.5 \times 10(2)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. A-4,5,6

Compressive strength (uniaxial) (MPa)
 Bentonite (Na) (b)
 ranges from: 8.9
 to: -
 Source: KBS TEKNISK RAPPORT 74 (1978),
 p. 14

Compressive strength (uniaxial) (MPa)
 Shale
 Ohio
 ranges from: 13.8
 to: -
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 108

Compressive strength (uniaxial) (psi)
 Shale
 Ohio
 ranges from: $1 \times 10(4)$ ($6.9 \times 10(1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Compressive strength (uniaxial) (psi)
 Shale
 Ohio
 ranges from: $2 \times 10(3)$ ($1.4 \times 10(1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Compressive strength (uniaxial) (psi)
 Shale (a)
 ranges from: 70 ($4.8 \times 10(-1)$ MPa)
 to: $3.7 \times 10(4)$ ($2.5 \times 10(2)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Compressive strength (uniaxial) (psi)
 Shale (a)
 ranges from: $2.1 \times 10(3)$ ($1.4 \times 10(1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Compressive strength (uniaxial) (psi)
 Shale (b)
 ranges from: $1 \times 10(4)$ ($6.9 \times 10(1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Friction angle (angle of shear resistance) (deg)
 Clay
 Belgium
 ranges from: 19
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Friction angle (angle of shear resistance) (deg)
 Clay
 Italy
 ranges from: 25
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Friction angle (deg)
 Shale
 Ohio
 ranges from: 23.4
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Friction angle (deg)
 Shale
 Ohio
 ranges from: 22
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Friction angle (deg)
 Shale (a)
 ranges from: 4.2
 to: 56
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Friction angle (deg)
 Shale (a)
 ranges from: 5.3
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Friction angle (deg)
 Shale (b)
 ranges from: 26
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Friction angle (dilation angle) (deg)
 Shale (c)
 ranges from: +5
 to: -5
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Friction angle (internal) (deg)
 Argillite
 ranges from: 35
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Friction angle (internal) (deg)
 Shale (b)
 Great Plains
 ranges from: 8
 to: 25
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Friction angle (internal) (deg)
 Shale (d)
 ranges from: 14.2
 to: 51.0
 Source: ORNL-6241/V1 (in preparation), p. 47

Friction angle (residual) (tan)
 Illite (Na) (a)
 ranges from: 0.3
 to: 0.7
 Source: ONWI-486 (1983), p. 47

Friction angle (residual) (tan)
 Illite (Na) (b)
 ranges from: 0.47
 to: 0.7
 Source: ONWI-486 (1983), p. 47

Friction angle (residual) (tan)
 Kaolinite
 ranges from: 0.27
 to: 0.7
 Source: ONWI-486 (1983), p. 47

Friction angle (residual) (tan)
 Smectite (Na) (a)
 ranges from: 0.09
 to: 0.7
 Source: ONWI-486 (1983), p. 47

Friction angle (residual) (tan)
 Smectite (Na) (b)
 ranges from: 0.18
 to: 0.7
 Source: ONWI-486 (1983), p. 47

Plasticity (liquid limit) (%)
 Bentonite
 Wyoming
 ranges from: 553.1
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (liquid limit) (%)
 Bentonite (a)
 Oregon
 ranges from: 209.6
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (liquid limit) (%)
 Bentonite (b)
 Oregon
 ranges from: 212.69
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (liquid limit) (%)
 Bentonite (Na)
 Wyoming
 ranges from: 260
 to: -
 Source: AECL-7825 (1984), p. 12

Plasticity (liquid limit) (%)
 Bentonite (Na) (a)
 ranges from: 98
 to: -
 Source: AECL-7825 (1984), p. 12

Plasticity (liquid limit) (%)
 Clay
 Belgium
 ranges from: 77.5
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Plasticity (liquid limit) (%)
 Clay
 England
 ranges from: 55
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Plasticity (liquid limit) (%)
 Clay
 Hanford
 ranges from: 44.6
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (liquid limit) (%)
 Clay
 Hanford
 ranges from: 63.9
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (liquid limit) (%)
 Clay
 Italy
 ranges from: 50
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Plasticity (liquid limit) (%)
 Illite (Ca)
 Jackson County, OH
 ranges from: 69
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Illite (Ca) (a)
 Elkhorn, IL
 ranges from: 90
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Illite (Ca) (b)
 Grundy County, IL
 ranges from: 100
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Kaolinite (Ca)
 Anna, IL
 ranges from: 73
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Kaolinite (Ca)
 Dry Branch, GA
 ranges from: 34
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Shale (a)
 Great Plains
 ranges from: 36
 to: 113
 Source: ORNL/Sub/84-64794/1 (1985), p. 291

Plasticity (liquid limit) (%)
 Shale (b)
 Great Plains
 ranges from: 55
 to: 202
 Source: ORNL/Sub/84-64794/1 (1985), p. 293

Plasticity (liquid limit) (%)
 Shales, Mudstones, Siltstones
 Various
 ranges from: 17.8
 to: 224
 Source: Y/ONWI/TM36/6 (1978), p. 6-20 to 6-26

Plasticity (liquid limit) (%)
 Smectite (Ca)
 Belle Fourche, SD
 ranges from: 177
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Smectite (Ca)
 Chaco, AZ
 ranges from: 155
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Smectite (Ca)
 Omsted, IL
 ranges from: 123
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquid limit) (%)
 Smectite (Ca)
 Pontotoc, MS
 ranges from: 166
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (liquidity index)
 Shale
 Montana
 ranges from: -0.11
 to: -
 Source: Y/ONI/TM36/6 (1978), p. 6-1

Plasticity (plastic index) (%)
 Bentonite
 Wyoming
 ranges from: 519.5
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic index) (%)
 Bentonite (a)
 Oregon
 ranges from: 168.58
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic index) (%)
 Bentonite (b)
 Oregon
 ranges from: 174.6
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic index) (%)
 Clay
 Hanford
 ranges from: 18.8
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic index) (%)
 Clay
 Hanford
 ranges from: 40.8
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic limit) (%)
 Bentonite
 Wyoming
 ranges from: 33.6
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic limit) (%)
 Bentonite (a)
 Oregon
 ranges from: 41.0
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic limit) (%)
 Bentonite (b)
 Oregon
 ranges from: 38.1
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic limit) (%)
 Bentonite (Na) (a)
 Wyoming
 ranges from: 50
 to: -
 Source: AECL-7825 (1984), p. 12

Plasticity (plastic limit) (%)
 Bentonite (Na) (b)
 Wyoming
 ranges from: 19
 to: -
 Source: AECL-7825 (1984), p. 12

Plasticity (plastic limit) (%)
 Clay
 Belgium
 ranges from: 26.5
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Plasticity (plastic limit) (%)
 Clay
 England
 ranges from: 26
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Plasticity (plastic limit) (%)
 Clay
 Hanford
 ranges from: 25.8
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic limit) (%)
 Clay
 Hanford
 ranges from: 23.1
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (plastic limit) (%)
 Clay
 Italy
 ranges from: 25
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Plasticity (plastic limit) (%)
 Illite (Ca)
 Jackson County, OH
 ranges from: 36
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Illite (Ca) (a)
 Elkhorn, IL
 ranges from: 40
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Illite (Ca) (b)
 Grundy County, IL
 ranges from: 42
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Kaolinite (Ca)
 Anna, IL
 ranges from: 36
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Kaolinite (Ca)
 Dry Branch, GA
 ranges from: 26
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Shale (a)
 Great Plains
 ranges from: 20
 to: 62
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 291

Plasticity (plastic limit) (%)
 Shale (b)
 Great Plains
 ranges from: 22
 to: 39
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Plasticity (plastic limit) (%)
 Shales, Mudstones, Siltstones
 Various
 ranges from: 16.0
 to: 45.5
 Source: Y/ONWI/TM36/6 (1978), p. 6-20 to
 6-26

Plasticity (plastic limit) (%)
 Smectite (Ca)
 Belle Fourche, SD
 ranges from: 63
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Smectite (Ca)
 Cheto, AZ
 ranges from: 65
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Smectite (Ca)
 Omsted, IL
 ranges from: 79
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plastic limit) (%)
 Smectite (Ca)
 Pontotoc, MS
 ranges from: 65
 to: -
 Source: ONWI-486 (1983), p. 43

Plasticity (plasticity index) (%)
 Bentonite (Na) (a)
 Wyoming
 ranges from: 210
 to: -
 Source: AECL-7825 (1984), p. 12

Plasticity (plasticity index) (%)
 Bentonite (Na) (b)
 Wyoming
 ranges from: 79
 to: -
 Source: AECL-7825 (1984), p. 12

Plasticity (plasticity index) (%)
 Clay
 Louisiana
 ranges from: 40
 to: -
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 173

Plasticity (plasticity index) (%)
 Illite
 ranges from: 0
 to: 90
 Source: ONWI-486 (1983), p. 45

Plasticity (plasticity index) (%)
 Kaolinite
 ranges from: 0
 to: 35
 Source: ONWI-486 (1983), p. 45

Plasticity (plasticity index) (%)
 Shale
 Great Plains
 ranges from: 30
 to: 110
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Plasticity (plasticity index) (%)
 Shales, Mudstones, Siltstones
 Various
 ranges from: 1.8
 to: 192
 Source: Y/ONWI/TM36/6 (1978), p. 6-20 to
 6-26

Plasticity (plasticity index) (%)
 Smectite (Na)
 ranges from: 0
 to: 500
 Source: ONWI-486 (1983), p. 45

Plasticity (shrinkage limit) (%)
 Bentonite (a)
 Oregon
 ranges from: 8.47
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (shrinkage limit) (%)
 Bentonite (b)
 Oregon
 ranges from: 8.96
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Plasticity (shrinkage limit) (%)
 Clay
 Hanford
 ranges from: 19.75
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Poisson's ratio
 Argillite
 ranges from: 0.30
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Poisson's ratio
 Bentonite
 Wyoming
 ranges from: 0.15
 to: -
 Source: ONWI-486 (1983), p. 63

Poisson's ratio
 Oil Shales
 ranges from: 0.2
 to: 0.3
 Source: ORNL/Sub/84-64794/1 (1985), p. 348

Poisson's ratio
 Oil Shales
 ranges from: 0.15
 to: 0.20
 Source: ORNL/Sub/84-64794/1 (1985), p. 348

Poisson's ratio
 Shale
 ranges from: 0.2
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Poisson's ratio
 Shale
 Ohio
 ranges from: 0.1
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Poisson's ratio
 Shale
 Ohio
 ranges from: 0.25
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Poisson's ratio
 Shale (a)
 ranges from: 0.03
 to: 0.50
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Poisson's ratio
 Shale (b)
 ranges from: 0.15
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Poisson's ratio
 Shales (a)
 ranges from: 0.11
 to: 0.31
 Source: ORNL-6241/V3 (in preparation) p. 110

Poisson's ratio
 Shales (b)
 Various
 ranges from: 0.03
 to: 0.77
 Source: Y/OWI/TM36/6 (1978), p. A-11

Ratio of strength to overburden stress
 Shale
 ranges from: 1.3
 to: 6.0
 Source: ORNL-6241/V1 (in preparation) p. 53

Shear modulus (Pa x 10(10))
 Shales (a)
 ranges from: 0.1 (1 x 10(3) MPa)
 to: 100 (1 x 10(6) MPa)
 Source: ORNL-6241/V2 (in preparation) p. 199

Shear modulus (psi)
 Shale
 ranges from: $6.2 \times 10(5)$ ($4.3 \times 10(3)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shear modulus (psi)
 Shale
 ranges from: $58.3 \times 10(3)$ ($4 \times 10(2)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Shear modulus (psi)
 Shale
 Ohio
 ranges from: $6.8 \times 10(5)$ ($4.7 \times 10(3)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Shear modulus (psi)
 Shale
 Ohio
 ranges from: $6.8 \times 10(4)$ ($4.7 \times 10(2)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Shear modulus (psi)	Swelling (%)
Shales (b)	Bentonite (c)
Various	ranges from: 1
ranges from: $1.7 \times 10(6)$ to: $3.6 \times 10(6)$	to: 50
($1.2 \times 10(4)$ MPa) ($2.5 \times 10(4)$ MPa)	Source: ONWI-486 (1983), p. 49
Source: Y/OWI/TM36/6 (1978), p. A-10	
Shear strength (kPa)	Swelling (%)
Bentonite (Na) (a)	Illite
ranges from: 1,600 to: <15	ranges from: <2
($1.6 \times 10(4)$ MPa) ($<1.5 \times 10(2)$ MPa)	to: 20
Source: KBS TEKNISK RAPPORT 74 (1978), p. 16	Source: ONWI-486 (1983), p. 49
Shear strength (MPa)	Swelling (%)
Bentonite (Na) (b)	Illite and Bentonite (a)
ranges from: 4.5 to: -	ranges from: 1
Source: KBS TEKNISK RAPPORT 74 (1978), p. 14	to: 54
Shear strength (undrained) (MPa)	Source: ONWI-486 (1983), p. 49
Clay	Swelling (%)
Belgium	Illite and Bentonite (b)
ranges from: 0.6 to: -	ranges from: <2
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	to: 30
Shear strength (undrained) (MPa)	Source: ONWI-486 (1983), p. 49
Clay	Swelling (%)
England	Illite and Kaolinite
ranges from: 1.2 to: -	ranges from: <2
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	to: <10
Shear strength (undrained) (MPa)	Source: ONWI-486 (1983), p. 49
Clay	Swelling (%)
Italy	Kaolinite
ranges from: 1.5 to: -	ranges from: <2
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	to: 4
Strength (MPa)	Source: ONWI-486 (1983), p. 49
Clay	Swelling (%)
Louisiana	Kaolinite and Bentonite
ranges from: 0.19 to: -	ranges from: 2
Source: ORNL/Sub/84-64794/1 (1985), p. 173	to: 35
Swelling (%)	Source: ONWI-486 (1983), p. 49
Bentonite (a)	Swelling (potential) (%)
ranges from: 5 to: 20	Shale
Source: KBS TEKNISK RAPPORT 9 (1977), p. 5	Canada
Swelling (%)	ranges from: 2
Bentonite (b)	to: 20
ranges from: 15 to: 30	Source: ORNL/Sub/84-64794/1 (1985), p. 293
Source: KBS TEKNISK RAPPORT 9 (1977), p. 6	Swelling (potential) (%)
	Shale
	Great Plains
	ranges from: 3
	to: 5
	Source: ORNL/Sub/84-64794/1 (1985), p. 293
	Swelling distance (mm)
	Bentonite
	ranges from: 1
	to: 11
	Source: ONWI-312 (1981), p. 16

Swelling pressure (kPa)
 Bentonite (a)
 ranges from: 30 (0.03 MPa) (?)
 to: 110 (0.11 MPa) (?)
 Source: KBS TEKNISK RAPPORT 9 (1977),
 p. 6

Swelling pressure (kPa)
 Bentonite (b)
 ranges from: 30 (0.03 MPa) (?)
 to: 200 (0.20 MPa) (?)
 Source: KBS TEKNISK RAPPORT 9 (1977),
 p. 6

Swelling pressure (MPa)
 Bentonite
 Oregon
 ranges from: ca. 0
 to: ca. 1.8
 Source: AECL-7812 (1983), p. 34

Swelling pressure (MPa)
 Bentonite
 Wyoming
 ranges from: ca. 0
 to: ca. 2.2
 Source: AECL-7812 (1983), p. 34

Swelling pressure (MPa)
 Bentonite (c)
 ranges from: 0.7
 to: ca. 70
 Source: AECL-7812 (1983), p. 33

Swelling pressure (MPa)
 Bentonite (Ca)
 ranges from: 31.4
 to: -
 Source: ONWI-312 (1981), p. 31

Swelling pressure (MPa)
 Bentonite (Na) (a)
 ranges from: >10
 to: -
 Source: ONWI-312 (1981), p. 15

Swelling pressure (MPa)
 Bentonite (Na) (b)
 ranges from: 57.7
 to: -
 Source: ONWI-312 (1981), p. 31

Swelling pressure (MPa)
 Bentonite (Na) (c)
 ranges from: 21.7
 to: -
 Source: ONWI-312 (1981), p. 31

Swelling pressure (MPa)
 Bentonite (Na) (d)
 ranges from: ca. 72
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Swelling pressure (MPa)
 Bentonite (Na) (e)
 Wyoming
 ranges from: ca. 3
 to: ca. 8
 Source: AECL-7825 (1984), p. 16

Swelling pressure (MPa)
 Bentonite (Na) (f)
 Wyoming
 ranges from: ca. 2
 to: ca. 20
 Source: AECL-7825 (1984), p. 16

Swelling pressure (MPa)
 Bentonite (Na) (g)
 Wyoming
 ranges from: 1
 to: 8
 Source: KBS TEKNISK RAPPORT 74 (1978),
 p. 6

Swelling pressure (MPa)
 Bentonite (Na) (h)
 Wyoming
 ranges from: 2
 to: 23
 Source: ONWI-486 (1983), p. 51

Swelling pressure (MPa)
 Bentonite (Na) (i)
 Wyoming
 ranges from: 3
 to: 26
 Source: ONWI-486 (1983), p. 51

Swelling pressure (MPa)
 Bentonite (Na) (j)
 Wyoming
 ranges from: 3
 to: 27
 Source: ONWI-486 (1983), p. 51

Swelling pressure (MPa)
 Bentonite and Sand (a)
 Oregon
 ranges from: ca. 0
 to: ca. 1.8
 Source: RHO-BWI-SA-80 (1981), Fig. 3

Swelling pressure (MPa)
 Bentonite and Sand (b)
 Wyoming
 ranges from: ca. 0
 to: ca. 2.2
 Source: RHO-BWI-SA-80 (1981), Fig. 3

Swelling pressure (MPa)
 Shale
 ranges from: 10
 to: 0.5
 Source: KBS TEKNISK RAPPORT 74 (1978),
 p. 7

Tensile strength (MPa)
 Argillite
 ranges from: 3.5
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 81

Tensile strength (MPa)

Shale (c)
Ohio
ranges from: 0.34
to: -
Source: ORNL/Sub/84-64794/1 (1985),
p. 108

Tensile strength (psi)

Shale
Ohio
ranges from: 200 (1.4 MPa)
to: -
Source: Y/OWI/TM36/6 (1978), p. 5-14

Tensile strength (psi)

Shale (a)
ranges from: 0 (0 MPa) (?)
to: 1,540 (1.1 x 10(1) MPa)
Source: Y/OWI/TM36/6 (1978), p. 2-2

Tensile strength (psi)

Shale (b)
ranges from: 200 (1.4 MPa)
to: -
Source: Y/OWI/TM36/6 (1978), p. 7-8

Tensile strength (psi)

Shale (d)
Ohio
ranges from: 50 (3.4 x 10(-1) MPa)
to: -
Source: Y/OWI/TM36/6 (1978), p. 4-12

Tensile strength (psi)

Shale (e)
ranges from: 50 (3.4 x 10(-1) MPa)
to: -
Source: Y/OWI/TM36/6 (1978), p. 3-24

Tensile strength (psi)

Shales
Various
ranges from: <100 (<6.9 x 10(-1) MPa)
to: 1,538 (1.1 x 10(1) MPa)
Source: Y/OWI/TM36/6 (1978), p. A-7

Young's modulus (elastic modulus) (MPa)

Clay
Belgium
ranges from: 170
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Young's modulus (elastic modulus) (MPa)

Clay
Italy
ranges from: 300
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Young's modulus (elastic modulus) (psi x 10(6))

Shale
ranges from: 1,48 (1 x 10(4) MPa)
to: -
Source: Y/OWI/TM36/6 (1978), p. 6-3

Young's modulus (elastic modulus) (psi x 10(6))

Shale
Great Plains
ranges from: 0.02 (1.4 x 10(2) MPa)
to: 0.014 (9.6 x 10(1) MPa)
Source: ORNL/Sub/84-64794/1 (1985),
p. 293

Young's modulus (GPa)

Argillite (a)
ranges from: 3.7 (3.7 x 10(3) MPa)
to: 16 (MPa)
Source: Proc NEA Workshop OECD (1979b),
p. 83

Young's modulus (GPa)

Shales (a)
ranges from: 9.9 (9.9 x 10(3) MPa)
to: 31.7 (3.17 x 10(4) MPa)
Source: ORNL-6241/V3 (In preparation)
p. 110

Young's modulus (MPa)

Bentonite
ranges from: 300
to: -
Source: ONWI-486 (1983), p. 63

Young's modulus (MPa)

Bentonite and Sand (a)
Oregon
ranges from: ca. 55
to: ca. 80
Source: RHO-BWI-SA-80 (1981), Fig. 5

Young's modulus (MPa)

Bentonite and Sand (b)
Wyoming
ranges from: ca. 45
to: 60
Source: RHO-BWI-SA-80 (1981), Fig. 5

Young's modulus (MPa)

Oil Shales
ranges from: 7,000 (7 x 10(3))
to: 17,500 (1.75 x 10(4))
Source: ORNL/Sub/84-64794/1 (1985),
p. 348

Young's modulus (MPa)

Oil Shales
ranges from: >21,000 (>2.1 x 10(4))
to: -
Source: ORNL/Sub/84-64794/1 (1985),
p. 348

Young's modulus (MPa)

Shale (a)
ranges from: 10
to: 32
Source: ORNL-6241/V1 (In preparation)
p. 47

Young's modulus (MPa)

Shale (b)
ranges from: 10
to: 32
Source: ORNL-6241/V1 (In preparation)
p. 47

Young's modulus (Pa $\times 10^{10}$)
 Shales (b)
 ranges from: 1 (1 $\times 10^4$ MPa)
 to: 500 (5 $\times 10^6$ MPa)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Young's modulus (psi)
 Shale
 ranges from: 1.4 $\times 10^5$ (9.7 $\times 10^2$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Young's modulus (psi)
 Shale
 Ohio
 ranges from: 1.5 $\times 10^6$ (1 $\times 10^4$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 5-14

Young's modulus (psi)
 Shale
 Ohio
 ranges from: 1.7 $\times 10^5$ (1.2 $\times 10^3$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Young's modulus (psi)
 Shale (c)
 ranges from: 2 $\times 10^3$ (1.4 $\times 10^1$ MPa)
 to: 6.4 $\times 10^6$ (4.4 $\times 10^4$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Young's modulus (psi)
 Shale (d)
 ranges from: 1.6 $\times 10^6$ (1.1 $\times 10^4$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Young's modulus (psi)
 Shales (c)
 Various
 ranges from: 0.0020 $\times 10^6$ (1.4 $\times 10^1$
 MPa)
 to: 15.0 $\times 10^6$ (1 $\times 10^5$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. A-8,9

Young's modulus (unconfined) (GPa)
 Argillite (b)
 ranges from: 3.74 (3.7 $\times 10^3$ MPa)
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 87

Coefficient of linear expansion (deg C(-1)) (K(-1))

Argillite
ranges from: $8 \times 10(-6)$ to: $15 \times 10(-6)$
Source: Proc NEA Workshop OECD (1979b), p. 77

Coefficient of linear thermal expansion (deg F(-1))

Shale (a)
ranges from: $4 \times 10(-6)$ (2.2 $\times 10(-6)$ K(-1)) to: -
Source: Y/OWI/TM36/6 (1978), p. 2-2

Coefficient of linear thermal expansion (horizontal) (deg F(-1))

Shale (b)
ranges from: $4.5 \times 10(-6)$ (2.5 $\times 10(-6)$ K(-1)) to: -
Source: Y/OWI/TM36/6 (1978), p. 7-8

Coefficient of linear thermal expansion (K(-1))

Shales (a)
ranges from: $2.5 \times 10(-6)$ to: $15.8 \times 10(-6)$
Source: ORNL-6241/V3 (in preparation) p. 345

Coefficient of linear thermal expansion (vertical) (deg F(-1))

Shale (c)
ranges from: $9 \times 10(-6)$ (5 $\times 10(-6)$ K(-1)) to: -
Source: Y/OWI/TM36/6 (1978), p. 7-8

Coefficient of thermal expansion (K(-1))

Shales (b)
ranges from: $2.9 \times 10(-6)$ to: $12.9 \times 10(-6)$
Source: ORNL-6241/V1 (in preparation) p. 47

Heat capacity (BTU/lb-deg F)

Shale
ranges from: 0.20 (8.4 $\times 10(2)$ J/Kg-K) to: -
Source: Y/OWI/TM36/6 (1978), p. 7-8

Heat capacity (BTU/lb-deg F)

Shales (a)
ranges from: 0.16 (6.7 $\times 10(2)$ J/Kg-K) to: 0.20 (8.4 $\times 10(2)$ J/Kg-K)
Source: Y/OWI/TM36/6 (1978), p. A-19

Heat capacity (J/Kg-K)

Shale (a)
ranges from: $5.5 \times 10(2)$ to: $1.042 \times 10(3)$
Source: ORNL-6241/V1 (in preparation) p. 40

Heat capacity (J/Kg-K)

Shale (b)
ranges from: $7.12 \times 10(2)$ to: $1.170 \times 10(3)$
Source: ORNL-6241/V3 (in preparation) p. 345

Heat conductivity (millical/cm s deg C) (thermal conductivity)

Clayey Sandstones
ranges from: 2.5 (1.05 W/m-K) to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 23

Heat conductivity (W/m-deg C) (thermal conductivity) (W/m-K)

Bentonite (a)
ranges from: 0.5 to: 2.0
Source: KBS TEKNISK RAPPORT 9 (1977), p. 8

Specific heat (J/Kg-deg C) (specific heat capacity) (J/Kg-K)

Shale (c)
ranges from: $7.96 \times 10(2)$ to: -
Source: ORNL-6241/V2 (in preparation) p. 57

Specific heat (J/Kg-K) (specific heat capacity)

Clay
Belgium
ranges from: $9.21 \times 10(2)$ to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Specific heat (J/Kg-K) (specific heat capacity)

Clay
Italy
ranges from: $9.21 \times 10(2)$ to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Specific heat (J/Kg-K) (specific heat capacity)

Shales (b)
ranges from: $5.50 \times 10(2)$ to: $1.042 \times 10(3)$
Source: ORNL-6241/V3 (in preparation) p. 115

Thermal conductivity (Btu per hr sq ft) (deg F per ft) (?)

Soils
Bristol, VA
ranges from: 0.14 to: 0.60
Source: Y/OWI/SUB-7009/1 (1976), p. 20

Thermal conductivity (Btu per hr sq ft) (deg F per ft) (?)
 Soils
 Columbus, MS
 ranges from: 0.28
 to: 2.28
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Thermal conductivity (Btu per hr sq ft) (deg F per ft) (?)
 Soils (a)
 Cleveland, TN
 ranges from: 0.15
 to: 0.94
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Thermal conductivity (Btu per hr sq ft) (deg F per ft) (?)
 Soils (b)
 Murfreesboro, TN
 ranges from: 0.21
 to: 0.84
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Thermal conductivity (BTU/ft-hr deg F)
 Shales (b)
 Various
 ranges from: 0.34 ($5.9 \times 10(-1)$ W/m-K)
 to: 1.77 (3.1 W/m-K)
 Source: Y/OWI/TM36/6 (1978), p. A-18

Thermal conductivity (horizontal)
 (BTU/hr-ft-deg F)
 Shale (b)
 ranges from: 1.1 (1.9 W/m-K)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Thermal conductivity (horizontal) (J/s m-deg C) (W/m-K)
 Shale (c)
 ranges from: 1.89
 to: -
 Source: ORNL-6241/V2 (In preparation)
 p. 99

Thermal conductivity (horizontal) (W/m-K)
 Shale (d)
 ranges from: 1.52
 to: 2.26
 Source: ORNL-6241/V1 (In preparation)
 p. 40

Thermal conductivity (horizontal) (W/m-K)
 Shales (a)
 ranges from: ca. 1.60
 to: ca. 2.20
 Source: ORNL-6241/V3 (In preparation)
 p. 117

Thermal conductivity (k x 10(4)) (?)
 Soils
 ranges from: 3
 to: 5
 Source: Y/OWI/SUB-7009/1 (1976), p. 19

Thermal conductivity (k x 10(4)) (?)
 Soils
 ranges from: 3-4
 to: 8-12
 Source: Y/OWI/SUB-7009/1 (1976), p. 19

Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 Argillite (a)
 ranges from: ca. 1.80
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 Argillite (b)
 ranges from: ca. 1.48
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 Clay (a)
 Belgium
 ranges from: ca. 0.3
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 Shale (I)
 ranges from: 0.7 to 2.1
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Thermal conductivity (millical/cm s deg C)
 Shale (a)
 England
 ranges from: 2.2 ($9.2 \times 10(-1)$ W/m-K)
 to: 5.3 (2.22 W/m-K)
 Source: Y/OWI/SUB-7009/1 (1976), p. 26

Thermal conductivity (millical/cm s deg C)
 Shale (h)
 England
 ranges from: 3.0 (1.26 W/m-K)
 to: 4.3 (1.80 W/m-K)
 Source: Y/OWI/SUB-7009/1 (1976), p. 26

Thermal conductivity (millical/cm s deg C)
 Shale (k)
 Sunderland, MA
 ranges from: 3.87 (1.62 W/m-K)
 to: 4.25 (1.78 W/m-K)
 Source: Y/OWI/SUB-7009/1 (1976), p. 28

Thermal conductivity (vertical)
 (BTU/hr-ft-deg F)
 Shale (e)
 ranges from: 0.8 (1.4 W/m-K)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Thermal conductivity (vertical) (W/m-K)
 Shale (f)
 ranges from: 1.21
 to: 1.57
 Source: ORNL-6241/V1 (in preparation)
 p. 40

Thermal conductivity (vertical) (W/m-K)
 Shales
 ranges from: 1.21
 to: 1.57
 Source: ORNL-6241/V3 (in preparation)
 p. 115

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (b)
 ranges from: ca. 0.75
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 148

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (c)
 ranges from: 0.7
 to: 3.0
 Source: Proc NEA Workshop OECD (1981),
 p. 342

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (Ca)
 ranges from: 0.71
 to: 1.10
 Source: PNL-4452 UC-70 (1983), p. 20

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (d)
 ranges from: 0.5
 to: 1.0
 Source: Proc NEA Workshop OECD (1981),
 p. 342

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (e)
 ranges from: 0.9
 to: 1.3
 Source: ONWI-486 (1983), p. 63

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (f)
 ranges from: 1
 to: 3.5
 Source: ONWI-486 (1983), p. 63

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (g)
 Wyoming
 ranges from: ca. 0.0
 to: ca. 1.2
 Source: Proc NEA Workshop OECD (1981),
 p. 334

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (h)
 Wyoming
 ranges from: 0.78
 to: -
 Source: ONWI-486 (1983), p. 61

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite (Na)
 ranges from: 0.52
 to: 0.96
 Source: PNL-4452 UC-70 (1983), p. 20

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite and Crushed Granite (a)
 Wyoming
 ranges from: 2.7
 to: 0.8
 Source: Proc NEA Workshop OECD (1981),
 p. 334

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite and Crushed Granite (b)
 Wyoming
 ranges from: ca. 0.6
 to: ca. 1.5
 Source: Proc NEA Workshop OECD (1981),
 p. 334

Thermal conductivity (W/m-deg C) (W/m-K)
 Bentonite and Sand (a)
 ranges from: 0.5
 to: 2.0
 Source: ONWI-486 (1983), p. 63

Thermal conductivity (W/m-deg C) (W/m-K)
 Clay
 S. Paolo mine
 ranges from: 0.014 (1.4 W/m-K)
 to: 0.016 (1.6 W/m-K)
 Source: ORNL-tr-5110 (1981), p. 12

Thermal conductivity (W/m-deg C) (W/m-K)
 Hectorite
 ranges from: 0.5
 to: 2 to 3
 Source: ONWI-312 (1981), p. 18

Thermal conductivity (W/m-deg C) (W/m-K)
 Illite (a)
 ranges from: ca. 0.6
 to: ca. 1.6
 Source: Proc NEA Workshop OECD (1981),
 p. 336

Thermal conductivity (W/m-deg C) (W/m-K)
 Illite (b)
 ranges from: 1.4
 to: 4.0
 Source: Proc NEA Workshop OECD (1981),
 p. 342

Thermal conductivity (W/m-deg C) (W/m-K)
 Illite (c)
 ranges from: 0.8
 to: 1.8
 Source: Proc NEA Workshop OECD (1981),
 p. 342

Thermal conductivity (W/m-deg C) (W/m-K)
 Illite and Crushed Granite
 ranges from: ca. 0.9
 to: ca. 1.9
 Source: Proc NEA Workshop OECD (1981),
 p. 336

Thermal conductivity (W/m-deg C) (W/m-K)
 Kaolinite (a)
 ranges from: 1.7
 to: 3.5
 Source: Proc NEA Workshop OECD (1981),
 p. 342

Thermal conductivity (W/m-deg C) (W/m-K)
 Kaolinite (b)
 ranges from: 0.9
 to: 2.0
 Source: Proc NEA Workshop OECD (1981),
 p. 342

Thermal conductivity (W/m-deg C) (W/m-K)
 Kaolinite and Crushed Granite
 ranges from: 3.4
 to: 2.3
 Source: Proc NEA Workshop OECD (1981),
 p. 334

Thermal conductivity (W/m-deg C) (W/m-K)
 Silt/Clay Soil (a)
 ranges from: 0.8
 to: 2.0
 Source: ONWI-486 (1983), p. 54

Thermal conductivity (W/m-deg C) (W/m-K)
 Silt/Clay Soil (b)
 ranges from: 0.4
 to: 0.85
 Source: ONWI-486 (1983), p. 54

Thermal conductivity (W/m-deg C) (W/m-K)
 Silt/Clay Soil (c)
 ranges from: 0.5
 to: 1.1
 Source: ONWI-486 (1983), p. 54

Thermal conductivity (W/m-deg C) (W/m-K)
 Silt/Clay Soil (d)
 ranges from: 0.6
 to: 1.3
 Source: ONWI-486 (1983), p. 54

Thermal conductivity (W/m-deg C) (W/m-K)
 Silt/Clay Soil (e)
 ranges from: 0.7
 to: 1.5
 Source: ONWI-486 (1983), p. 54

Thermal conductivity (W/m-deg C) (W/m-K)
 Silt/Clay Soil (f)
 ranges from: 0.75
 to: 1.75
 Source: ONWI-486 (1983), p. 54

Thermal conductivity (W/m-K)
 Argillite (c)
 Nevada
 ranges from: 1.28
 to: 2.7
 Source: ORNL-6241/V3 (In preparation)
 p. 341, 342

Thermal conductivity (W/m-K)
 Bentonite and Salt (a)
 ranges from: 1.12
 to: 0.99
 Source: ONWI-486 (1983), p. 53

Thermal conductivity (W/m-K)
 Bentonite and Salt (b)
 ranges from: 1.01
 to: 1.12
 Source: ONWI-486 (1983), p. 53

Thermal conductivity (W/m-K)
 Bentonite and Sand (b)
 ranges from: 0.58-0.80
 to: 1.06-1.17
 Source: ONWI-486 (1983), p. 53

Thermal conductivity (W/m-K)
 Clay
 England
 ranges from: 1.56
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle v. 6 (1985), p. 54

Thermal conductivity (W/m-K)
 Clay
 Italy
 ranges from: 1.5
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle v. 6 (1985), p. 54

Thermal conductivity (W/m-K)
 Clay (b)
 Belgium
 ranges from: 1.5
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle v. 6 (1985), p. 54

Thermal conductivity (W/m-K)
 Shale
 ranges from: 1.42
 to: 1.94
 Source: ORNL-6241/V3 (In preparation)
 p. 341

Thermal conductivity (W/m-K)
 Shale
 Kansas
 ranges from: 0.7
 to: 4.3
 Source: ORNL-6241/V3 (In preparation)
 p. 343

Thermal conductivity (W/m-K)
 Shale
 Michigan
 ranges from: 2.64
 to: -
 Source: ORNL-6241/V3 (In preparation)
 p. 341

Thermal conductivity (W/m-K)	Thermal diffusivity (cm ² /h)
Shale	Clay
Orange Free State	S. Paolo mine
ranges from: 1.97	ranges from: 20 ($5.56 \times 10(-7)$ m ² /s)
to: 2.89	to: -
Source: ORNL-6241/V3 (In preparation)	Source: ORNL-tr-5110 (1981), p. 12
p. 341	
Thermal conductivity (W/m-K)	Thermal diffusivity (cm ² /s $\times 10(3)$)
Shale	Bentonite (Na)
South Africa	
ranges from: 2.76	ranges from: 3.03 ($3.03 \times 10(-7)$ m ² /s)
to: -	to: 3.47 ($3.47 \times 10(-7)$ m ² /s)
Source: ORNL-6241/V3 (In preparation)	Source: PNL-4452 UC-70 (1983), p. 18, 19
p. 343	
Thermal conductivity (W/m-K)	Thermal diffusivity (ft ² per hr)
Shale (i)	Solts
England	Bristol, VA
ranges from: 1.26	ranges from: 0.0090 ($2.3 \times 10(-7)$ m ² /s)
to: 1.80	to: 0.016 ($4.13 \times 10(-7)$ m ² /s)
Source: ORNL-6241/V3 (In preparation)	Source: Y/OWI/SUB-7009/1 (1976), p. 21
p. 341	
Thermal conductivity (W/m-K)	Thermal diffusivity (ft ² per hr)
Shale (j)	Solts
Massachusetts	Columbus, MS
ranges from: 1.62	ranges from: 0.016 ($4.13 \times 10(-7)$ m ² /s)
to: -	to: 0.046 ($1.19 \times 10(-7)$ m ² /s)
Source: ORNL-6241/V3 (In preparation)	Source: Y/OWI/SUB-7009/1 (1976), p. 21
p. 341	
Thermal conductivity (W/m-K)	Thermal diffusivity (ft ² per hr)
Shale (m)	Solts (a)
ranges from: 0.715	Cleveland, TN
to: 2.20	ranges from: 0.0115 ($2.97 \times 10(-7)$ m ² /s)
Source: ORNL-6241/V3 (In preparation)	to: 0.022 ($5.68 \times 10(-7)$ m ² /s)
p. 340	Source: Y/OWI/SUB-7009/1 (1976), p. 21
Thermal conductivity (W/m-K)	Thermal diffusivity (ft ² per hr)
Shale (n)	Solts (b)
ranges from: 1.38	Murfreesboro, TN
to: 1.9	ranges from: 0.0145 ($3.74 \times 10(-7)$ m ² /s)
Source: ORNL-6241/V3 (In preparation)	to: 0.0235 ($6.06 \times 10(-7)$ m ² /s)
p. 341	Source: Y/OWI/SUB-7009/1 (1976), p. 21
Thermal conductivity (W/m-K)	Thermal diffusivity (m ² /s)
Shales	Clay
ranges from: 1.47	Belgium
to: 2.00	ranges from: $8.1 \times 10(-7)$
Source: ORNL-6241/V3 (In preparation)	to: -
p. 340	Source: Rad Waste Management and Nuclear
Thermal conductivity (W/m-K)	Fuel Cycle v. 6 (1985), p. 54
Shales	
California	
ranges from: 0.99 ± 0.3	
to: 1.63 ± 0.3	
Source: ORNL-6241/V3 (In preparation)	
p. 341	
Thermal conductivity ratio (vertical/horizontal)	Thermal diffusivity (m ² /s)
Shale (g)	Clay
ranges from: 0.76	Italy
to: -	ranges from: $7.8 \times 10(-7)$
Source: ORNL-6241/V2 (In preparation)	to: -
p. 99	Source: Rad Waste Management and Nuclear
	Fuel Cycle v. 6 (1985), p. 54

13.3 Appendix C. MATERIALS

Allophane	Bentonite (Na)
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (ml/g)
ranges from: 70	ranges from: $1.1 \times 10(3)$
to: -	to: $1.0 \times 10(3)$
Source: ORNL-6241/V2 (in preparation)	Source: ONWI-312 (1981), p. 35
p. 152	
Argillite	Bentonite (Na)
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (ml/g)
ranges from: 0	ranges from: 0
to: $1 \times 10(5)$	to: $4 \times 10(4)$
Source: ONWI-486 (1983), p. 73	Source: ONWI-486 (1983), p. 73
Attapulgite	Bentonite (Na) (a)
Sorption coefficient (Kd) (ml/g)	Wyoming
ranges from: $1 \times 10(-2)$	Ion exchange capacity (meq/100 g)
to: $2 \times 10(4)$	ranges from: 68.6
Source: ONWI-486 (1983), p. 73	to: -
	Source: AECL-7825 (1984), p. 12
Bentonite	Bentonite (Na) (Accofloc-350)
Diffusivity (m²/s)	Sorption coefficient (Kd) (ml/g)
ranges from: $1.3 \times 10(-10)$	ranges from: $1.3 \times 10(3)$
to: -	to: $1.1 \times 10(3)$
Source: ONWI-312 (1981), p. 14	Source: ONWI-312 (1981), p. 35
Bentonite	Bentonite (Na) (Accofloc-350)
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (ml/g)
ranges from: 0.1	ranges from: 1.2
to: 100	to: 0.1
Source: NUREG/CP-0052 (1983), p. 181	Source: ONWI-312 (1981), p. 35
Bentonite	Bentonite (Na) (Accofloc-350)
Sorption coefficient (Kd) (ml/g?)	Sorption coefficient (Kd) (ml/g)
ranges from: 1	ranges from: $1.5 \times 10(3)$
to: $2 \times 10(5)$	to: $1.5 \times 10(3)$
Source: Proc NEA Workshop OECD (1979a),	Source: ONWI-312 (1981), p. 35
p. 304	
Bentonite (Ca)	Bentonite (Na) (b)
Sorption coefficient (Kd) (ml/g)	Wyoming
ranges from: $2.5 \times 10(4)$	Ion exchange capacity (meq/100 g)
to: $1.1 \times 10(5)$	ranges from: 34.3
Source: ONWI-312 (1981), p. 35	to: -
	Source: AECL-7825 (1984), p. 12
Bentonite (Ca)	Bentonite (Na) (Saline Seal-100)
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (ml/g)
ranges from: 2.5	ranges from: $2.6 \times 10(3)$
to: 3.2	to: $3.8 \times 10(3)$
Source: ONWI-312 (1981), p. 35	Source: ONWI-312 (1981), p. 35
Bentonite (Ca)	Bentonite (Na) (Saline Seal-100)
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (ml/g)
ranges from: $1.2 \times 10(3)$	ranges from: 2.8
to: 865	to: 3.6
Source: ONWI-312 (1981), p. 35	Source: ONWI-312 (1981), p. 35
Bentonite (Na)	Bentonite (Na) (Saline Seal-100)
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (ml/g)
ranges from: $5.0 \times 10(3)$	ranges from: $1.2 \times 10(3)$
to: $6.8 \times 10(3)$	to: $1.5 \times 10(3)$
Source: ONWI-312 (1981), p. 35	Source: ONWI-312 (1981), p. 35
Bentonite (Na)	Bentonite and Quartz
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (ml/g)
ranges from: 0.4	ranges from: <1
to: 8.6	to: $1 \times 10(4)$
Source: ONWI-312 (1981), p. 35	Source: ONWI-486 (1983), p. 73

Bentonite and Sand	Illite
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (m(3)/kg) (?)
ranges from: 490	ranges from: 0.9
to: $9.5 \times 10(3)$	to: -
Source: ONWI-486 (1983), p. 73	Source: AECL-7812 (1983), p. 25
Chlorite (a)	Illite
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (m(3)/kg) (?)
ranges from: 10-40	ranges from: 0.005
to: -	to: 0.02
Source: ONWI-486 (1983), p. 67	Source: AECL-7812 (1983), p. 25
Chlorite (b)	Illite
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (m(3)/kg) (?)
ranges from: 10	ranges from: 0.045
to: 40	to: 0.090
Source: ORNL-6241/V2 (in preparation)	Source: AECL-7825 (1984), p. 25
p. 152	
Clay	Illite
Belgium	Sorption coefficient (Kd) (ml/g)
Ion exchange capacity (meq/100 g)	ranges from: 0
ranges from: ca. 20	to: $3 \times 10(5)$
to: -	Source: ORNL-6241/V2 (in preparation)
Source: Proc NEA Workshop OECD (1979a),	p. 132-133
p. 88	
Clay	Illite
Belgium	Sorption coefficient (Kd) (ml/g?)
Sorption coefficient (Kd) (ml/g?)	ranges from: 1
ranges from: 0.87	to: $3 \times 10(6)$
to: 6.12	Source: Proc NEA Workshop OECD (1979a),
Source: Proc NEA Workshop OECD (1979a),	p. 304
p. 97	
Clay (Na)	Illite (a)
Belle Fourch	Ion exchange capacity (meq/100 g)
Sorption coefficient (Kd) (ml/g)	ranges from: 10
ranges from: 5.6	to: 40
to: $5.7 \times 10(3)$	Source: ONWI-486 (1983), p. 67
Source: ONWI-486 (1983), p. 73	
Glaucite	Illite (b)
Ion exchange capacity (meq/100 g)	Ion exchange capacity (meq/100 g)
ranges from: 11	ranges from: 16
to: 20	to: 50
Source: ORNL-6241/V2 (in preparation)	Source: ORNL-6241/V2 (in preparation)
p. 152	p. 152
Halloysite	Kaolinite
Ion exchange capacity (meq/100 g)	Sorption coefficient (Kd) (m(3)/kg) (?)
ranges from: 5	ranges from: 0.003
to: 10	to: 0.006
Source: ORNL-6241/V2 (in preparation)	Source: AECL-7812 (1983), p. 25
p. 152	
Hectorite	Kaolinite
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (m(3)/kg) (?)
ranges from: 0.4	ranges from: 0.002
to: $7.2 \times 10(3)$	to: 0.04
Source: ONWI-486 (1983), p. 73	Source: AECL-7812 (1983), p. 25
Hectorite and Sand	Kaolinite
Sorption coefficient (Kd) (ml/g)	Sorption coefficient (Kd) (m(3)/kg) (?)
ranges from: 400	ranges from: 0.02
to: 1300	to: -
Source: ONWI-486 (1983), p. 73	Source: AECL-7812 (1983), p. 25
	Kaolinite
	Sorption coefficient (Kd) (ml/g)
	ranges from: 0.1
	to: $1.6 \times 10(3)$
	Source: ONWI-486 (1983), p. 73

Kaolinite

Sorption coefficient (Kd) (ml/g)
 ranges from: 0
 to: $3 \times 10(5)$
 Source: ORNL-6241/V2 (in preparation)
 p. 132-133

Kaolinite

Sorption coefficient (Kd) (ml/g?)
 ranges from: 1
 to: $2 \times 10(4)$
 Source: Proc NEA Workshop OECD (1979a),
 p. 304

Kaolinite (a)**Georgia**

Batch distribution ratio (Rd) (ml/g?)
 ranges from: $1.28 \times 10(2)$
 to: $9.22 \times 10(2)$
 Source: PNL-4452 UC-70 (1983), p. 18

Kaolinite (a)

Ion exchange capacity (meq/100 g)
 ranges from: 3
 to: 15
 Source: ONWI-486 (1983), p. 67

Kaolinite (b)**Georgia**

Batch distribution ratio (Rd) (ml/g?)
 ranges from: $1.88 \times 10(2)$
 to: $9.0 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Kaolinite (b)

Ion exchange capacity (meq/100 g)
 ranges from: 2
 to: 15
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Kaolinite (Ca)

Sorption coefficient (Kd) (Log) (ml/g?)
 ranges from: ca. 2.3
 to: ca. 1.5
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Kaolinite (Ca)

Sorption coefficient (Kd) (Log) (ml/g?)
 ranges from: ca. 1.3
 to: ca. (-1)
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Kaolinite (Na)

Sorption coefficient (Kd) (Log) (ml/g?)
 ranges from: ca. 2.3
 to: ca. 1.3
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Kaolinite (Na)

Sorption coefficient (Kd) (Log) (ml/g?)
 ranges from: >2
 to: <0
 Source: Proc NEA Workshop OECD (1979a),
 p. 282

Nontronite

Sorption coefficient (Kd) (ml/g)
 ranges from: 0
 to: $2.25 \times 10(5)$
 Source: ONWI-486 (1983), p. 73

Polygorskite

Ion exchange capacity (meq/100 g)
 ranges from: 20
 to: 30
 Source: ORNL-6241/V2 (in preparation)
 p. 152

Shale

Sorption coefficient (Kd) (ml/g)
 ranges from: 57
 to: 100
 Source: ONWI-486 (1983), p. 73

Shale

Sorption coefficient (Kd) (ml/g)
 ranges from: 200
 to: $1.4 \times 10(4)$
 Source: ONWI-486 (1983), p. 73

Smectite**Arizona**

Batch distribution ratio (Rd) (ml/g?)
 ranges from: $8.15 \times 10(2)$
 to: $2.7 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Smectite**Texas**

Batch distribution ratio (Rd) (ml/g?)
 ranges from: $1.4 \times 10(3)$
 to: $1.9 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Smectite**Wyoming**

Batch distribution ratio (Rd) (ml/g?)
 ranges from: $1.0 \times 10(3)$
 to: $2.0 \times 10(3)$
 Source: PNL-4452 UC-70 (1983), p. 18

Smectite

Ion exchange capacity (meq/100 g)
 ranges from: 80
 to: 150
 Source: ONWI-486 (1983), p. 67

Smectite

Sorption coefficient (Kd) (cm(3)/g) (ml/g)
 ranges from: ca. 188
 to: ca. 200
 Source: NUREG/CP-0052 (1983), p. 186

Smectite

Sorption coefficient (Kd) (m(3)/kg) (?)
 ranges from: 0,06
 to: 0,7
 Source: AECL-7812 (1983), p. 25

Smectite

Sorption coefficient (Kd) (m(3)/kg) (?)
 ranges from: 0,034
 to: 0,65
 Source: AECL-7812 (1983), p. 25

Smectite
Sorption coefficient (Kd) (ml/g) (?)
 ranges from: 0.030
 to: 0.6
 Source: AECL-7812 (1983), p. 25

Smectite
Sorption coefficient (Kd) (ml/g)
 ranges from: 0
 to: $4 \times 10(5)$
 Source: ORNL-6241/V2 (In preparation)
 p. 132-133

Smectite
Arizona
Sorption coefficient (Kd) (ml/g)
 ranges from: 260
 to: 750
 Source: ONWI-486 (1983), p. 73

Smectite
Texas
Sorption coefficient (Kd) (ml/g)
 ranges from: 310
 to: 685
 Source: Sci Basis for Waste Management - V (1982), p. 638

Smectite
Texas
Sorption coefficient (Kd) (ml/g)
 ranges from: 410
 to: 400
 Source: Sci Basis for Waste Management - V (1982), p. 638

Smectite
Texas
Sorption coefficient (Kd) (ml/g)
 ranges from: 310
 to: 370
 Source: Sci Basis for Waste Management - V (1982), p. 638

Smectite
Wyoming
Sorption coefficient (Kd) (ml/g)
 ranges from: 170
 to: 200
 Source: Sci Basis for Waste Management - V (1982), p. 638

Smectite
Sorption coefficient (ml/g)
 ranges from: 200
 to: 2,000
 Source: ONWI-312 (1981), p. 13

Smectite (Ca)
Ion exchange capacity (meq/100 g)
 ranges from: 80
 to: 150
 Source: ORNL-6241/V2 (In preparation)
 p. 152

Smectite (Ca)
Ion exchange capacity (meq/g) (?)
 ranges from: 93
 to: 12
 Source: ONWI-312 (1981), p. 24

Smectite (Ca)
Sorption coefficient (Kd) (ml/g)
 ranges from: 0.4
 to: $1.1 \times 10(4)$
 Source: ONWI-486 (1983), p. 73

Smectite (L1)
Ion exchange capacity (meq/g) (?)
 ranges from: 56
 to: 20
 Source: ONWI-312 (1981), p. 24

Smectite (Na)
Ion exchange capacity (meq/100 g)
 ranges from: 100
 to: 150
 Source: ORNL-6241/V2 (In preparation)
 p. 152

Smectite (Na)
Ion exchange capacity (meq/g) (?)
 ranges from: 95
 to: 68
 Source: ONWI-312 (1981), p. 24

Smectite (Na)
Sorption coefficient (Kd) (ml/g)
 ranges from: 0.2
 to: $1 \times 10(5)$
 Source: ONWI-486 (1983), p. 73

Vermiculite
Sorption coefficient (Kd) (ml/g)
 ranges from: 47
 to: $1.5 \times 10(3)$
 Source: ONWI-486 (1983), p. 73

Vermiculite
South Carolina
Sorption coefficient (Kd) (ml/g)
 ranges from: $8.9 \times 10(2)$
 to: $1.01 \times 10(4)$
 Source: Sci Basis for Waste Management - V (1982), p. 638

Vermiculite
South Carolina
Sorption coefficient (Kd) (ml/g)
 ranges from: $2 \times 10(3)$
 to: $9.8 \times 10(2)$
 Source: Sci Basis for Waste Management - V (1982), p. 638

Vermiculite
Sorption coefficient (Kd) (ml/g?)
 ranges from: ca. 40
 to: $4 \times 10(4)$
 Source: Proc NEA Workshop OECD (1979), p. 315

Vermiculite
Sorption coefficient (Kd) (ml/g?)
ranges from: 30
to: $4 \times 10(6)$
Source: Proc NEA Workshop OECD (1979a),
p. 304

Vermiculite (a)
Ion exchange capacity (meq/100 g)
ranges from: 100
to: 150
Source: ONWI-486 (1983), p. 67

Vermiculite (b)
Ion exchange capacity (meq/100 g)
ranges from: 100
to: 150+
Source: ORNL-6241/V2 (in preparation)
p. 152

Vermiculite and Gibbsite
Sorption coefficient (Kd) (ml/g)
ranges from: 77
to: 1520
Source: ONWI-486 (1983), p. 73

Vermiculite and Shale
Sorption coefficient (Kd) (ml/g)
ranges from: 41
to: 1340
Source: ONWI-486 (1983), p. 73

Vermiculite and Smectite
Sorption coefficient (Kd) (ml/g)
ranges from: 192
to: 3800
Source: ONWI-486 (1983), p. 73

Vermiculite and Zeolite (various)
Sorption coefficient (Kd) (ml/g)
ranges from: 130
to: $5.92 \times 10(5)$
Source: ONWI-486 (1983), p. 73

Argillite
Nevada
Density (bulk) (g/cm(3))
ranges from: 2.44
to: 2.71
Source: ORNL/Sub/84-64794/1 (1985),
p. 406

Argillite
Nevada
Moisture content (%)
ranges from: 2
to: 4
Source: ORNL/Sub/84-64794/1 (1985),
p. 406

Argillite
Nevada
Porosity (%)
ranges from: 8 to 16
to: 6 to 12
Source: ORNL/Sub/84-64794/1 (1985),
p. 406

Bentonite (a)
Density (bulk) (t/m(3)) (g/cm(3))
ranges from: ca. 2.1
to: -
Source: Proc NEA Workshop OECD (1979b),
p. 148

Bentonite (a)
Specific gravity (dimensionless)
ranges from: 2.21
to: -
Source: Proc NEA Workshop OECD (1981),
p. 340

Bentonite (a)
Oregon
Specific gravity (g/cm(3))
ranges from: 2.73
to: -
Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (b)
Black Hills
Specific gravity (dimensionless)
ranges from: 2.18
to: -
Source: Proc NEA Workshop OECD (1981),
p. 340

Bentonite (b)
Oregon
Specific gravity (g/cm(3))
ranges from: 2.85
to: -
Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (c)
Wyoming
Specific gravity (g/cm(3))
ranges from: 2.77
to: -
Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (Ca)
Density (g/cm(3))
ranges from: <1.7
to: ca. 2.14
Source: PNL-4452 UC-70 (1983), p. 24

Bentonite (Na)
Wyoming
Density (specific) (t/m(3)) (g/cm(3))
ranges from: 2.7
to: -
Source: KBS TEKNISK RAPPORT 74 (1978),
p. 3

Bentonite (Na)
Wyoming
Specific gravity (dimensionless)
ranges from: 2.66
to: -
Source: AECL-7825 (1984), p. 12

Bentonite (Na)
Specific surface (m(2)/g)
ranges from: 519
to: 615
Source: AECL-7825 (1984), p. 12

Bentonite (Na) (a)
Density (bulk) (t/m(3)) (g/cm(3))
ranges from: 1.8
to: 2.0
Source: KBS TEKNISK RAPPORT 9 (1977),
p. 4

Bentonite (Na) (a)
Density (g/cm(3))
ranges from: <1.8
to: 2.28
Source: ONWI-312 (1981), p. 32

Bentonite (Na) (b)
Density (bulk) (t/m(3)) (g/cm(3))
ranges from: 1.4
to: 1.7
Source: KBS TEKNISK RAPPORT 9 (1977),
p. 4

Bentonite (Na) (b)
Density (g/cm(3))
ranges from: <1.8
to: ca. 2.5
Source: PNL-4452 UC-70 (1983), p. 21

Bentonite (Na) (c)
Wyoming
Density (bulk) (rho x t/m(3)) (g/cm(3))
ranges from: 2.54
to: 1.08
Source: KBS TEKNISK RAPPORT 74 (1978),
p. 4

Bentonite (Na) and Sand
Wyoming
Specific gravity (dimensionless)
ranges from: 2.635
to: -
Source: AECL-7825 (1984), p. 12

Bentonite (Na) and Sand
Specific surface (m²/g)

ranges from: 284

to: -

Source: AECL-7825 (1984), p. 12

Bentonite (Na) and Sand (a)
Density (g/cm³)

ranges from: <1.9

to: ca. 2.8

Source: PNL-4452 UC-70 (1983), p. 22

Bentonite (Na) and Sand (b)
Density (g/cm³)

ranges from: <1.9

to: ca. 2.7

Source: PNL-4452 UC-70 (1983), p. 23

Bentonite and Sand

Density (dry) (Mg/m³) (g/cm³)

ranges from: 1.81

to: 1.4

Source: AECL-7812 (1983), p. 31

Bentonite and Sand

Moisture content (%)

ranges from: 13

to: 22

Source: AECL-7812 (1983), p. 31

Bentonite and Sand

Porosity (effective) (units not stated)

ranges from: ca. 0.4

to: 0.002

Source: AECL-7812 (1983), p. 32

Chlorite

Density (dry) (presumed g/cm³)

ranges from: 2.6

to: 2.96

Source: Y/OMI/SUB-7009/1 (1976), p. 9

Clay

Belgium

Density (bulk) (kg/m³)

ranges from: 2010 (2.010 g/cm³)

to: -

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Clay

England

Density (bulk) (kg/m³)

ranges from: 2210 (2.210 g/cm³)

to: -

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Clay

Italy

Density (bulk) (kg/m³)

ranges from: 2100 (2.100 g/cm³)

to: -

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Clay

Louisiana

Density (kg/m³)

ranges from: 1,954 (1.954 g/cm³)

to: -

Source: ORNL/Sub/84-64794/1 (1985),

p. 173

Clay

Belgium

Porosity (%)

ranges from: 38.5

to: -

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Clay

England

Porosity (%)

ranges from: 30

to: -

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Clay

Italy

Porosity (%)

ranges from: 25

to: -

Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54

Clay

Hanford

Specific gravity (g/cm³)

ranges from: 2.71

to: -

Source: RHO-BWI-SA-80 (1981), p. 6

Clay and Sand

Density (dry) (kg/m³) (?) (g/cm³) (?)

ranges from: ca. 1.6

to: ca. 2.2

Source: RHO-BWI-SA-80 (1981), p. 6

Clays

Void ratio (dimensionless)

ranges from: ca. 1.5 to 3.0

to: ca. 0.5 to 0.6

Source: OMNI-312 (1981), p. 21

Clays and Shales

Eastern US

Density (grain) (average) (presumed g/cm³)

ranges from: 2.69

to: -

Source: Y/OMI/SUB-7009/1 (1976), p. 10

Illite

Density (presumed g/cm³)

ranges from: 2.65

to: 2.13

Source: Y/OMI/SUB-7009/1 (1976), p. 9

Illite

Porosity (effective) (units not stated)

ranges from: ca. 0.5

to: ca. 0.002

Source: AECL-7812 (1983), p. 32

Illite and Smectite		
Density (presumed g/cm(3))		
ranges from: 2.64		
to: 1.48		
Source: Y/OWI/SUB-7009/1 (1976), p. 9		
Kaolinite		
Density (dry) (Mg/m(3)) (g/cm(3))		
ranges from: ca. 1.2		
to: ca. 1.5		
Source: AECL-7812 (1983), p. 35		
Kaolinite		
Density (presumed g/cm(3))		
ranges from: 2.60 - 2.68		
to: 2.43		
Source: Y/OWI/SUB-7009/1 (1976), p. 9		
Kaolinite		
Porosity (effective) (units not stated)		
ranges from: ca. 0.5		
to: ca. 0.002		
Source: AECL-7812 (1983), p. 32		
Kaolinite		
Specific gravity (dimensionless)		
ranges from: 2.60		
to: -		
Source: Proc NEA Workshop OECD (1981), p. 340		
Kaolinite (Ca)		
Void ratio (dimensionless)		
ranges from: 2.5		
to: 1.0		
Source: ORNL-486 (1983), p. 38		
Kaolinite (Na)		
Void ratio (dimensionless)		
ranges from: 2.5		
to: 1.0		
Source: ORNL-486 (1983), p. 38		
Kaolinite and Sand		
Density (dry) (Mg/m(3)) (g/cm(3))		
ranges from: 2.05		
to: 1.45		
Source: AECL-7812 (1983), p. 31		
Kaolinite and Sand		
Moisture content (%)		
ranges from: 10		
to: 30		
Source: AECL-7812 (1983), p. 31		
Oil Shales		
Density (bulk) (presumed g/cm(3))		
ranges from: 1.506		
to: 2.37		
Source: Y/OWI/SUB-7009/1 (1976), p. 13		
Shale		
Illinois, Indiana and Kentucky		
Density (bulk) (average) (g/cm(3))		
ranges from: 2.36		
to: 2.53		
Source: ORNL-5703 (1983), p. 76		
Shale		
Michigan		
Density (bulk) (g/cm(3))		
ranges from: 2.2		
to: 2.8		
Source: ORNL/Sub/84-64794/1 (1985), p. 96		
Shale		
Ohio		
Density (bulk) (g/cm(3))		
ranges from: 2.65		
to: -		
Source: ORNL/Sub/84-64794/1 (1985), p. 108		
Shale		
Montana		
Density (dry) (average) (lbs/ft(3))		
ranges from: 118 (1,890 g/cm(3))		
to: -		
Source: Y/OWI/TM36/6, p. 6-1		
Shale		
Northern Great Plains		
Density (dry) (lb/cu ft)		
ranges from: 95 (1,522 g/cm(3))		
to: 110 (1,762 g/cm(3))		
Source: ORNL/Sub/84-64794/1 (1985), p. 293		
Shale		
California		
Density (presumed g/cm(3))		
ranges from: 2.5		
to: -		
Source: Y/OWI/SUB-7009/1 (1976), p. 12		
Shale		
Montana		
Density (wet) (average) (pounds/ft(3))		
ranges from: 135 (2,162 g/cm(3))		
to: -		
Source: Y/OWI/TM36/6, p. 6-1		
Shale		
New Mexico		
Moisture content (%)		
ranges from: 3.7		
to: 6.2		
Source: Y/OWI/TM36/6, p. 8-5		
Shale		
Ohio		
Moisture content (natural) (%)		
ranges from: 2		
to: -		
Source: Y/OWI/TM36/6, p. 5-14		
Shale		
Ohio		
Moisture content (natural) (%)		
ranges from: 4		
to: -		
Source: Y/OWI/TM36/6, p. 4-12		

Shale
New Mexico
Moisture content (rock) (%)
ranges from: 3
to: 11
Source: Y/OWI/TM36/6, p. 8-3

Shale
Porosity (%)
ranges from: 33
to: -
Source: Y/OWI/TM36/6, p. 3-24

Shale
Colorado
Porosity (%)
ranges from: 4.1
to: 5.1
Source: Y/OWI/SUB-7009/1 (1976), p. 14

Shale
Tennessee
Porosity (%)
ranges from: 0.5
to: 1.9
Source: ORNL-6241/V2 (in preparation)
p. 219

Shale
Ohio
Porosity (effective) (%)
ranges from: 4
to: -
Source: Y/OWI/TM36/6, p. 5-14

Shale
Porosity (effective) (units not stated)
ranges from: 0.05
to: 0.005
Source: ORNL-6241/V1 (in preparation)
p. 33

Shale
South Carolina
Porosity (effective) (units not stated)
ranges from: 0.005
to: -
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Ohio
Porosity (primary) (%)
ranges from: >3 %
to: -
Source: ORNL/Sub/84-64794/1 (1985),
p. 108

Shale
Porosity (rock mass) (%)
ranges from: 3.0
to: -
Source: Y/OWI/TM36/6, p. 7-8

Shale
Ohio
Porosity (rock mass) (%)
ranges from: 8
to: -
Source: Y/OWI/TM36/6, p. 4-12

Shale
Porosity (total) (units not stated)
ranges from: 0.1
to: 0.01
Source: ORNL-6241/V1 (in preparation)
p. 33

Shale
Great Britain
Porosity (total) (units not stated)
ranges from: 0.020
to: 0.101
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Illinois, Indiana, Kentucky
Porosity (total) (units not stated)
ranges from: 0.009
to: 0.046
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Kansas
Porosity (total) (units not stated)
ranges from: 0.073
to: 0.106
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Kentucky
Porosity (total) (units not stated)
ranges from: 0.074
to: 0.076
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Michigan
Porosity (total) (units not stated)
ranges from: 0.03
to: 0.10
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Missouri
Porosity (total) (units not stated)
ranges from: 0.113
to: -
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Pennsylvania
Porosity (total) (units not stated)
ranges from: 0.010
to: -
Source: ORNL-6241/V2 (in preparation)
p. 52

Shale
Tennessee
Porosity (total) (units not stated)
 ranges from: 0.005
 to: 0.019
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Shale
Utah
Porosity (total) (units not stated)
 ranges from: 0.009
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Shale
Michigan
Specific surface (m²)/g)
 ranges from: 0.05
 to: 1.2
 Source: ORNL-5703 (1983), p. 109

Shale
Montana
Water content (average) (%)
 ranges from: 15
 to: -
 Source: Y/OWI/TM36/6, p. 6-1

Shale (a)
Density (bulk) (presumed g/cm³)
 ranges from: 2.1
 to: 2.5
 Source: Y/OWI/SUB-7009/1 (1976), p. 12

Shale (a)
Density (kg/m³)
 ranges from: 2,123 (2,123 g/cm³)
 to: 3,003 (3,003 g/cm³)
 Source: ORNL-6241/V1 (in preparation)
 p. 40

Shale (a)
Moisture content (natural) (%)
 ranges from: 0
 to: 38
 Source: Y/OWI/TM36/6, p. 2-2

Shale (a)
Porosity (%)
 ranges from: 30
 to: 5 to 10
 Source: ORNL-6241/V2 (in preparation)
 p. 218

Shale (a)
Michigan
Porosity (%)
 ranges from: 3
 to: 10
 Source: ORNL-5703 (1983), p. 106

Shale (a)
Illinois, Indiana and Kentucky
Porosity (average) (vol. %)
 ranges from: 0.95
 to: 4.64
 Source: ORNL-5703 (1983), p. 76

Shale (a)
Porosity (effective) (units not stated)
 ranges from: 0.01
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 99

Shale (a)
Porosity (total) (units not stated)
 ranges from: 0.03
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 99

Shale (b)
Density (grain) (average) (presumed g/cm³)
 ranges from: 2.71
 to: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 10

Shale (b)
Density (kg/m³)
 ranges from: 2,563 (2,563 g/cm³)
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 99

Shale (b)
Moisture content (natural) (%)
 ranges from: 1.5
 to: -
 Source: Y/OWI/TM36/6, p. 7-8

Shale (b)
Illinois, Indiana, Kentucky
Porosity (%)
 ranges from: 0.95
 to: 4.64
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 85

Shale (b)
Michigan
Porosity (%)
 ranges from: 3
 to: 10
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 98

Shale (b)
Porosity (rock mass) (%)
 ranges from: 0
 to: 45
 Source: Y/OWI/TM36/6, p. 2-2

Shale (b)
Porosity (total) (units not stated)
 ranges from: 0.03
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Shale (c)
Density (presumed g/cm³)
 ranges from: 2.4
 to: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 8

Shale (c)	Shale (g)
Moisture content (natural) (%)	Density (presumed g/cm(3))
ranges from: 18	ranges from: 2.2
to: -	to: -
Source: Y/OWI/TM36/6, p. 3-24	Source: Y/OWI/SUB-7009/1 (1976), p. 8
Shale (c)	Shale (h)
Porosity (total) (units not stated)	Density (presumed g/cm(3))
ranges from: 0.003	ranges from: 2.5
to: 0.056	to: -
Source: ORNL-6241/V2 (In preparation)	Source: Y/OWI/SUB-7009/1 (1976), p. 8
p. 52	
Shale (d)	Shale (i)
Density (presumed g/cm(3))	Density (presumed g/cm(3))
ranges from: 2.65	ranges from: 2.0
to: -	to: -
Source: Y/OWI/SUB-7009/1 (1976), p. 8	Source: Y/OWI/SUB-7009/1 (1976), p. 8
Shale (d)	Shale (j)
Northern Great Plains	Gulf Coast
Moisture content (natural) (%)	Density (g/cm(3))
ranges from: 18	ranges from: 2.1
to: 38	to: 2.3
Source: ORNL/Sub/84-64794/1 (1985),	Source: Y/OWI/SUB-7009/1 (1976), p. 121
p. 293	
Shale (d)	Shale (k)
Ohio	Gulf Coast
Porosity (total) (units not stated)	Density (presumed g/cm(3))
ranges from: 0.03	ranges from: 2.58
to: -	to: -
Source: ORNL-6241/V2 (In preparation)	Source: Y/OWI/SUB-7009/1 (1976), p. 12
p. 52	
Shale (e)	Shales
Density (presumed g/cm(3))	New York, Kentucky, Virginia and West
ranges from: 2.2	Virginia
to: -	Density (bulk) (average) (g/cm(3))
Source: Y/OWI/SUB-7009/1 (1976), p. 8	ranges from: 2.61
	to: 2.68
	Source: ORNL-5703 (1983), p. 37
Shale (e)	Shales
Western USA	Black Hills
Moisture content (%)	Density (bulk) (presumed g/cm(3))
ranges from: 35	ranges from: 1.559
to: 15	to: 2.038
Source: Y/OWI/TM36/6, p. 3-1	Source: Y/OWI/SUB-7009/1 (1976), p. 14
Shale (e)	Shales
Pennsylvania	Eastern Canada
Porosity (total) (units not stated)	Density (bulk) (presumed g/cm(3))
ranges from: 0.0117	ranges from: 2.07
to: -	to: 2.68
Source: ORNL-6241/V2 (In preparation)	Source: Y/OWI/SUB-7009/1 (1976), p. 15
p. 52	
Shale (f)	Shales
Density (presumed g/cm(3))	Oklahoma
ranges from: 2.3	Density (bulk) (presumed g/cm(3))
to: -	ranges from: 2.1
Source: Y/OWI/SUB-7009/1 (1976), p. 8	to: 2.62
	Source: Y/OWI/SUB-7009/1 (1976), p. 16
Shale (f)	Shales
Scotland	Western Canada
Porosity (total) (units not stated)	Density (bulk) (presumed g/cm(3))
ranges from: 0.016	ranges from: 2.43
to: -	to: 2.71
Source: ORNL-6241/V2 (In preparation)	Source: Y/OWI/SUB-7009/1 (1976), p. 17
p. 52	

Shales
Density (dry) (presumed g/cm(3))
 ranges from: 1.55
 to: 2.55
 Source: Y/OWI/SUB-7009/1 (1976), Fig. 1

Shales
Black Hills
Density (grain) (average) (presumed g/cm(3))
 ranges from: 2.66
 to: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 10

Shales
Kansas
Density (grain) (average) (presumed g/cm(3))
 ranges from: 2.72
 to: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 10

Shales
Venezuela
Density (grain) (average) (presumed g/cm(3))
 ranges from: 2.69
 to: -
 Source: Y/OWI/SUB-7009/1 (1976), p. 10

Shales
Density (lbs/ft(3))
 ranges from: 117 (1.874 g/cm(3))
 to: 188 (3.011 g/cm(3))
 Source: Y/OWI/TM36/6, p. A-2, 3 & 4

Shales
Density (wet) (presumed g/cm(3))
 ranges from: 1.98
 to: 2.67
 Source: Y/OWI/SUB-7009/1 (1976), Fig. 1

Shales
Moisture content (natural) (%)
 ranges from: 38
 to: 12
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Shales
Porosity (%)
 ranges from: 0.7 (70% ?)
 to: 0.1 (10% ?)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Shales
Appalachian Basin
Porosity (%)
 ranges from: ca. 3
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Shales
Illinois Basin
Porosity (%)
 ranges from: 0.9
 to: 4.6
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Shales (a)
Kentucky
Porosity (%)
 ranges from: 3.3
 to: 10.1
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Shales (b)
Kentucky
Porosity (%)
 ranges from: 15
 to: 3
 Source: Y/OWI/SUB-7009/1 (1976), p. 16

Shales
Michigan Basin
Porosity (%)
 ranges from: 3
 to: 10
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Shales
Oklahoma
Porosity (%)
 ranges from: 25
 to: 2
 Source: Y/OWI/SUB-7009/1 (1976), p. 16

Shales
USA and Europe
Porosity (%)
 ranges from: 19
 to: 1
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Shales
Kentucky, New York, Virginia and West Virginia
Porosity (average) (vol. %)
 ranges from: 2.86 to 3.87
 to: -
 Source: ORNL-5703 (1983), p. 37

Shales
Pennsylvania
Porosity (effective) (%)
 ranges from: 1.17
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Shales
South Carolina
Porosity (effective) (%)
 ranges from: ca. 0.5
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 219

Shales (a)
Density (bulk) (g/cm(3))
 ranges from: 1.6
 to: 2.5
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Shales (a)	Smectite (Ca)
Moisture content (%)	Void ratio (dimensionless)
ranges from: 1.3	ranges from: 7.0
to: 38	to: 1.0
Source: Y/ONI/TM36/6, p. A-13, 14 & 15	Source: ONI-486 (1983), p. 38
Shales (a)	Smectite (Na)
Porosity (%)	Void ratio (dimensionless)
ranges from: 3	ranges from: 30.0
to: 15	to: 1.0
Source: ORNL-6241/V2 (In preparation)	Source: ONI-486 (1983), p. 38
p. 218	
Shales (b)	
Density (bulk) (presumed g/cm(3))	
ranges from: 2.40	
to: 2.43	
Source: Y/ONI/SUB-7009/1 (1976), p. 16	
Shales (b)	
Porosity (%)	
ranges from: 15 to 45	
to: 3 to 20	
Source: ORNL-6241/V2 (In preparation)	
p. 219	
Shales (b)	
Water content (vol %)	
ranges from: 70 to 90	
to: 5 to 10	
Source: ORNL-6241/V2 (In preparation)	
p. 218	
Shales (c)	
Density (natural) (presumed g/cm(3))	
ranges from: 2.43	
to: 2.65	
Source: Y/ONI/SUB-7009/1 (1976), p. 18	
Shales (c)	
Porosity (%)	
ranges from: 0.4	
to: 7.2	
Source: Y/ONI/SUB-7009/1 (1976), p. 18	
Shales (d)	
Porosity (%)	
ranges from: 0.0	
to: 44.6	
Source: Y/ONI/TM36/6, p. A-12	
Shales (e)	
Germany	
Porosity (%)	
ranges from: 25	
to: ca. 0	
Source: Y/ONI/SUB-7009/1 (1976), p. 15	
Smectite	
Density (presumed g/cm(3))	
ranges from: 2.2-2.7	
to: 1.77	
Source: Y/ONI/SUB-7009/1 (1976), p. 9	
Smectite	
Specific surface (m(2)/g)	
ranges from: 800	
to: -	
Source: NUREG/CP-0052 (1983), p. 182	

Bentonite (Ca)
Hydraulic conductivity (cm/s)
 ranges from: $1.5 \times 10(-12)$ and $1.6 \times 10(-12)$
 to:
 Source: ONWI-312 (1981), p. 33

Bentonite (Ca)
Hydraulic conductivity (cm/s)
 ranges from: $7 \times 10(-12)$
 to: $2 \times 10(-12)$
 Source: PNL-4452 UC-70 (1983), p. 14

Bentonite (Ca) and (Na)
Permeability (m²)
 ranges from: $1 \times 10(-16)$ ($9.7 \times 10(-8)$ cm/s)
 to:
 Source: NUREG/CP-0052 (1983), p. 209

Bentonite (Na)
Hydraulic conductivity (cm/s)
 ranges from: $2.7 \times 10(-9)$
 to: $0.7 \times 10(-9)$
 Source: ONWI-312 (1981), p. 34

Bentonite (Na)
 Wyoming
Hydraulic conductivity (cm/s)
 ranges from: Not stated
 to: $10(-9)$
 Source: ONWI-486 (1983), p. 61

Bentonite (Na) (a)
Hydraulic conductivity (cm/s x 10(12))
 ranges from: <1 ($<1 \times 10(-12)$ cm/s)
 to: ca. 8 (ca. $8 \times 10(-12)$ cm/s)
 Source: ONWI-312 (1981), p. 11

Bentonite (Na) (b)
Hydraulic conductivity (cm/s)
 ranges from: ca. $1 \times 10(-13)$
 to:
 Source: ONWI-312 (1981), p. 10

Bentonite (Na) (c)
Hydraulic conductivity (cm/s)
 ranges from: $4.6 \times 10(-12)$ and $6.4 \times 10(-12)$
 to:
 Source: ONWI-312 (1981), p. 33

Bentonite (Na) (d)
Hydraulic conductivity (cm/s)
 ranges from: $6.6 \times 10(-10)$
 to:
 Source: ONWI-312 (1981), p. 33

Bentonite (Na) (e)
Hydraulic conductivity (cm/s)
 ranges from: $5.6 \times 10(-13)$
 to:
 Source: ONWI-312 (1981), p. 33

Bentonite (Na) (f)
Hydraulic conductivity (cm/s)
 ranges from: $6 \times 10(-12)$
 to: $6 \times 10(-13)$
 Source: PNL-4452 UC-70 (1983), p. 13

Bentonite (Na) (g)
Hydraulic conductivity (cm/s)
 ranges from: $1.2 \times 10(-12)$
 to: $8.3 \times 10(-13)$
 Source: PNL-4452 UC-70 (1983), p. 27

Bentonite (Na) (h)
Permeability (cm/s) (hydraulic conductivity)
 ranges from: $1 \times 10(-11)$
 to:
 Source: ONWI-312 (1981), p. 10

Bentonite (Na) (i)
Permeability (cm/s) (hydraulic conductivity)
 ranges from: $3 \times 10(-8)$
 to: $1.5 \times 10(-9)$
 Source: ONWI-312 (1981), p. 10

Bentonite (Na) (j)
Permeability (m/s) (hydraulic conductivity)
 ranges from: $5 \times 10(-15)$ ($5 \times 10(-13)$ cm/s)
 to: $1 \times 10(-11)$ ($1 \times 10(-9)$ cm/s)
 Source: KBS TEKNISK RAPPORT 74 (1978), p. 8

Bentonite (Na) (k)
Permeability (m/s) (hydraulic conductivity)
 ranges from: ca. $1 \times 10(-11)$ (ca. $1 \times 10(-9)$ cm/s)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Bentonite (Na) (l)
Permeability (m/s) (hydraulic conductivity)
 ranges from: ca. $3 \times 10(-11)$ (ca. $3 \times 10(-9)$ cm/s)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Bentonite (Na) (m)
Permeability (m/s) (hydraulic conductivity)
 ranges from: $1 \times 10(-10)$ ($1 \times 10(-8)$ cm/s) (maximum)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 5

Bentonite (Na) and (Ca)
 Various
Hydraulic conductivity (cm/s)
 ranges from: $10(-4)$
 to: $10(-12)$
 Source: ONWI-486 (1983), p. 36

Bentonite (Na) and Sand
Hydraulic conductivity (cm/s)
 ranges from: ca. $10(-9)$
 to: ca. $10(-12)$
 Source: PNL-4452 UC-70 (1983), p. 16

Bentonite and Sand

Hydraulic conductivity (m/s)
 ranges from: ca. 10^{-6} (ca. 1×10^{-4} cm/s)
 to: ca. 10^{-14} (ca. 1×10^{-12} cm/s)
 Source: AECL-7812 (1983), p. 29

Bentonite and Sand (a)

Oregon
Permeability (cm/s) (hydraulic conductivity)
 ranges from: 9.5×10^{-8}
 to:
 Source: RHO-BWI-SA-80 (1981), p. 7

Bentonite and Sand (b)

Oregon
Permeability (cm/s) (hydraulic conductivity)
 ranges from: $< 9.5 \times 10^{-8}$
 to:
 Source: RHO-BWI-SA-80 (1981), p. 7

Bentonite and Sand (c)

Wyoming
Permeability (cm/s) (hydraulic conductivity)
 ranges from: $< 9.5 \times 10^{-8}$
 to:
 Source: RHO-BWI-SA-80 (1981), p. 7

Bentonite and Sand (d)

Wyoming
Permeability (cm/s) (hydraulic conductivity)
 ranges from: $< 9.5 \times 10^{-8}$
 to:
 Source: RHO-BWI-SA-80 (1981), p. 7

Bentonite and Sand (e)

Wyoming
Permeability (m(2))
 ranges from: 3×10^{-18} (2.9×10^{-9} cm/s)
 to:
 Source: NUREG/CP-0052 (1983), p. 220

Bentonite and Sand (f)

Wyoming
Permeability (m(2))
 ranges from: 8×10^{-18} (7.8×10^{-9} cm/s)
 to:
 Source: NUREG/CP-0052 (1983), p. 220

Clay

Permeability (m/s) (hydraulic conductivity)
 ranges from: 1×10^{-9} (1×10^{-7} cm/s)
 to:
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 4

Clay

Louisiana
Hydraulic conductivity (cm/s)
 ranges from: 10^{-8} (est)
 to:
 Source: ORNL/Sub/84-64794/1 (1985), p. 175

Clay

Belgium
Hydraulic conductivity (m/s)
 ranges from: 10^{-10} (1×10^{-8} cm/s)
 to: 10^{-12} (1×10^{-10} cm/s)
 Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Clay

England
Hydraulic conductivity (m/s)
 ranges from: 10^{-12} (1×10^{-10} cm/s)
 to:
 Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Clay

Italy
Hydraulic conductivity (m/s)
 ranges from: 10^{-11} (1×10^{-9} cm/s)
 to:
 Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Clay and Sand

Hanford
Permeability (cm/s) (hydraulic conductivity)
 ranges from: $< 9.5 \times 10^{-8}$
 to:
 Source: RHO-BWI-SA-80 (1981), p. 7

Clays and Shales

Permeability (md)
 ranges from: 8×10^{-4} (7.7×10^{-10} cm/s)
 to: 2×10^{-6} (1.9×10^{-12} cm/s)
 Source: Proc NEA Workshop OECD (1979b), p. 69

Illite (Ca)

Hydraulic conductivity (cm/s)
 ranges from: 10^{-10}
 to: 10^{-6}
 Source: OMNI-486 (1983), p. 35

Illite (Na)

Hydraulic conductivity (cm/s)
 ranges from: 10^{-10}
 to: 10^{-7}
 Source: OMNI-486 (1983), p. 35

Kaolinite (a)

Permeability (m(2))
 ranges from: 1×10^{-16} (9.7×10^{-8} cm/s)
 to:
 Source: NUREG/CP-0052 (1983), p. 209

Kaolinite (b)

Permeability (m(2))
 ranges from: 5×10^{-17} (4.9×10^{-8} cm/s)
 to:
 Source: NUREG/CP-0052 (1983), p. 209

Shale Hydraulic conductivity (vertical) (m/s) ranges from: $1 \times 10(-11)$ (1 $\times 10(-9)$ cm/s) to: $1 \times 10(-13)$ (1 $\times 10(-11)$ cm/s) Source: ORNL-6241/V1 (in preparation) p. 33	Shale Colorado Permeability (md) ranges from: < 0.05 ($< 4.9 \times 10(-7)$ cm/s) to: Source: Y/OWI/SUB-7009/1 (1976), p. 14
Shale Hydraulic conductivity (vertical) (m/s) ranges from: $1 \times 10(-12)$ (1 $\times 10(-10)$ cm/s) to: Source: ORNL-6241/V2 (in preparation) p. 99	Shale Gulf Coast Permeability (md) ranges from: $1 \times 10(-8)$ ($9.6 \times 10(-15)$ cm/s) (?) to: $2.5 \times 10(-9)$ ($2.4 \times 10(-15)$ cm/s) (?) Source: Y/OWI/SUB-7009/1 (1976), p. 11
Shale Inflow (ml/min per m) ranges from: $1 \times 10(-1)$ to: $5 \times 10(-1)$ Source: ORNL-6241/V1 (in preparation) p. 38	Shale Michigan Permeability (md) ranges from: 0.001 (1 $\times 10(-9)$ cm/s) to: 2.0 ($1.9 \times 10(-6)$ cm/s) Source: ORNL-5703 (1983), p. 109
Shale Inflow (ml/min per m) ranges from: 10 to: <1 Source: ORNL-6241/V2 (in preparation) p. 106	Shale Michigan Permeability (md) ranges from: 0.001 (1 $\times 10(-9)$ cm/s) to: 2.0 ($1.9 \times 10(-6)$ cm/s) Source: ORNL/Sub/84-64794/1 (1985), p. 98
Shale Ohio Permeability (ft/yr) (hydraulic conductivity) ranges from: $10(-3)$ ($9.7 \times 10(-10)$ cm/s) to: $10(-4)$ ($9.7 \times 10(-11)$ cm/s) Source: Y/OWI/TM36/6 (1978), p. 5-14	Shale Permeability (vertical) (factor of K horizontal) ranges from: $1/2Kh$ to: $1/10Kh$ Source: Y/OWI/TM36/6 (1978), p. 2-2
Shale Permeability (horizontal) (ft/yr) (hydraulic conductivity) ranges from: 0.01 ($9.7 \times 10(-9)$ cm/s) to: Source: Y/OWI/TM36/6 (1978), p. 3-24	Shale Permeability (vertical) (ft/yr) (hydraulic conductivity) ranges from: 0.005 ($5 \times 10(-9)$ cm/s) to: Source: Y/OWI/TM36/6 (1978), p. 3-24
Shale Ohio Permeability (horizontal) (ft/yr) (hydraulic conductivity) ranges from: 0.1 ($9.7 \times 10(-8)$ cm/s) to: Source: Y/OWI/TM36/6 (1978), p. 4-12	Shale Ohio Permeability (vertical) (ft/yr) (hydraulic conductivity) ranges from: 0.05 ($5 \times 10(-8)$ cm/s) to: Source: Y/OWI/TM36/6 (1978), p. 4-12
Shale Permeability (md) ranges from: $5 \times 10(-2)$ ($4.9 \times 10(-7)$ cm/s) to: Source: Y/OWI/SUB-7009/1 (1976), p. 11	Shale Specific storage (1/m) ranges from: $1 \times 10(-6)$ to: Source: ORNL-6241/V2 (in preparation) p. 99
Shale California Permeability (md) ranges from: $4 \times 10(-4)$ ($3.8 \times 10(-10)$ cm/s) to: Source: Y/OWI/SUB-7009/1 (1976), p. 11	Shale Specific storage (1/m) ranges from: $4.3 \times 10(-7)$ to: $2.8 \times 10(-6)$ Source: ORNL-6241/V2 (in preparation) p. 57

Shale
Specific storage ($m(-1)$) (?)
ranges from: $5 \times 10(-6)$
to: $5 \times 10(-7)$
Source: ORNL-6241/V1 (In preparation)
p. 33

Shale
Travel time (years)
ranges from: >100,000
to: >100,000
Source: ORNL-6241/V1 (in preparation)
p. 36

Shale (a)
Hydraulic conductivity (horizontal) (m/s)
ranges from: 1×10^{-11} (1×10^{-9}
cm/s)
to:
Source: ORNL-6241/V2 (in preparation)
p. 106

Shale (a)
 Permeability (ft/yr) (hydraulic conductivity)
 ranges from: 0.1 (9.7×10^{-8} cm/s)
 to: 0.05 (4.8×10^{-8} cm/s)
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (a)
 Permeability (md)
 ranges from: 1.1×10^{-4} ($1.1 \times$
 10^{-10} cm/s)
 to:
 Source: Y/DWI/SUB-7009/1 (1976), p. 11

Shale (b)
Great Plains
Permeability (cm/s) (hydraulic conductivity)
 ranges from: 1×10^{-6}
 to: 1×10^{-10}
Source: ORNL/Sub/84-64794/1 (1985),
p. 293

Shale (b)
Permeability (microdarcies)
 ranges from: 100 (1×10^{-7} cm/s)
 to: 0.01 (1×10^{-9} cm/s)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Shale (c)
 Hydraulic conductivity (horizontal) (m/s)
 ranges from: $1 \times 10(-11)$ ($1 \times 10(-9)$
 cm/s)
 to: $7 \times 10(-9)$ ($7 \times 10(-7)$
 cm/s)
 Source: ORNL-6241/V2 (in preparation)
 p. 42

Shale (d)
Hydraulic conductivity (horizontal) (m/s)
ranges from: 1×10^{-11} (1×10^{-9}
cm/s)
to: 1×10^{-6} (1×10^{-4}
cm/s)
Source: ORNL-6241/V2 (in preparation)
p. 43

Shale (e)
 Permeability (horizontal) (ft/yr) (hydraulic conductivity)
 ranges from: $1 \times 10(-4)$ ($9.7 \times 10(-11)$ cm/s)
 to: $1 \times 10(3)$ ($9.7 \times 10(-4)$ cm/s)

Shales
East Coast
Hydraulic conductivity (cm/s)
ranges from: $10(-7)$
to: $10(-11)$
Source: ORNL-6241/V2 (in preparation)
p. 220

Shales ~ Michigan and Appalachian Basins
Hydraulic conductivity (cm/s)
ranges from: 10^{-6}
to: 10^{-9}
Source: ORNL-6241/V2 (In preparation)
p. 220

Shales
Northern Great Plains
Hydraulic conductivity (cm/s)
ranges from: 10^{-6}
to: 10^{-10}
Source: ORNL-6241/V2 (in preparation)
p. 220

Shales
Permeability (md)
ranges from: $8 \times 10(-4)$ $(7.7 \times 10(-10))$
cm/s
to: $2 \times 10(-6)$ $(1.9 \times 10(-12))$
cm/s

Shales
Illinois
Permeability (md)
 ranges from: $2 \times 10(-6)$ $(1.9 \times 10(-12)$
 cm/s)
 to:
 Source: YOWI/SUB-7009/1 (1976), p. 11

Shales
Montana
Permeability (md)
 ranges from: 6×10^{-4} (5.8×10^{-10})
 cm/s
 to:
 Source: Y/ONI/SUB-7009/1 (1976), p. 11

Shales	Siltstone/Mudstone
New Mexico	South Carolina
Permeability (md)	Hydraulic conductivity (horizontal) (cm/s)
ranges from: $2 \times 10(-6)$ (1.9 x $10(-12)$ cm/s)	ranges from: $1 \times 10(-13)$ (1 x $10(-11)$ cm/s)
to:	to: $5 \times 10(-10)$ (5 x $10(-8)$ cm/s)
Source: Y/OWI/SUB-7009/1 (1976), p. 11	Source: ORNL-6241/V2 (in preparation) p. 43
Shales	Silty Clay
Oklahoma	Hydraulic conductivity (cm/s)
Permeability (md)	ranges from: $5 \times 10(-6)$
ranges from: $8 \times 10(-4)$ (7.7 x $10(-10)$ cm/s)	to: ca. $2 \times 10(-8)$
to:	Source: ONWI-486 (1983), p. 39
Source: Y/OWI/SUB-7009/1 (1976), p. 11	
Shales	Silty Clay
Texas	Hydraulic conductivity (cm/s)
Permeability (md)	ranges from: $5 \times 10(-6)$
ranges from: $3 \times 10(-4)$ (2.9 x $10(-10)$ cm/s)	to: $10(-7)$
to: $7 \times 10(-6)$ (6.7 x $10(-12)$ cm/s)	Source: ONWI-486 (1983), p. 39
Source: Y/OWI/SUB-7009/1 (1976), p. 11	
Shales	Smectite (Ca) (a)
Utah	Hydraulic conductivity (cm/s)
Permeability (md)	ranges from: $10(-11)$
ranges from: $7 \times 10(-6)$ (6.7 x $10(-12)$ cm/s)	to: $10(-6)$
to:	Source: ONWI-486 (1983), p. 35
Source: Y/OWI/SUB-7009/1 (1976), p. 11	
Shales (c)	Smectite (Ca) (b)
Hydraulic conductivity (cm/s)	Permeability (m(2))
ranges from: $10(-8)$	ranges from: $3 \times 10(-18)$ (2.9 x $10(-9)$ cm/s)
to: $10(-11)$	to:
Source: ORNL-6241/V2 (in preparation) p. 218	Source: NUREG/CP-0052 (1983), p. 209
Shales (d)	Smectite (Ca) and Sand
Hydraulic conductivity (cm/s)	Permeability (m(2))
ranges from: $10(-9)$	ranges from: $4 \times 10(-17)$ (3.9 x $10(-8)$ cm/s)
to: $10(-11)$	to:
Source: ORNL-6241/V2 (in preparation) p. 219	Source: NUREG/CP-0052 (1983), p. 209
Shales (e)	Smectite (Na) (a)
Permeability (m(2))	Hydraulic conductivity (cm/s)
ranges from: $10(-17)$ (9.7 x $10(-9)$ cm/s)	ranges from: $10(-11)$
to: $10(-21)$ (9.7 x $10(-13)$ cm/s)	to: $10(-7)$
Source: ORNL-6241/V2 (in preparation) p. 199	Source: ONWI-486 (1983), p. 35
Shales (f)	Smectite (Na) and Sand
Various	Permeability (m(2))
Permeability (ft/yr) (hydraulic conductivity)	ranges from: $5 \times 10(-19)$ (4.9 x $10(-10)$ cm/s)
ranges from: $1.0 \times 10(-4)$ (9.7 x $10(-11)$ cm/s)	to:
to: $1.1 \times 10(3)$ (1.1 x $10(-4)$ cm/s)	Source: NUREG/CP-0052 (1983), p. 209
Source: Y/OWI/TM36/6 (1978), p. A-16	
	Volclay saline seal and Sand
	Hydraulic conductivity (cm/s)
	ranges from: $2.9 \times 10(-12)$
	to: $4.1 \times 10(-12)$
	Source: ONWI-312 (1981), p. 33

Argillite	Bentonite
Bulk modulus (confined) (GPa)	Wyoming
ranges from: 14.0 (1.4 x 10(4) MPa)	Plasticity (plastic limit) (%)
to: -	ranges from: 33.6
Source: Proc NEA Workshop OECD (1979b),	to: -
p. 87	Source: RHO-BWI-SA-80 (1981), p. 6
Argillite	Bentonite
Cohesion (unconfined) (MPa)	Wyoming
ranges from: 8 x 10(-1)	Poisson's ratio
to: -	ranges from: 0.15
Source: Proc NEA Workshop OECD (1979b),	to: -
p. 87	Source: ONWI-486 (1983), p. 63
Argillite	Bentonite
Compressive strength (unconfined) (MPa)	Swelling distance (mm)
ranges from: 4.75	ranges from: 1
to: -	to: 11
Source: Proc NEA Workshop OECD (1979b),	Source: ONWI-312 (1981), p. 16
p. 87	
Argillite	Bentonite
Friction angle (internal) (deg)	Oregon
ranges from: 35	Swelling pressure (MPa)
to: -	ranges from: ca. 0
Source: Proc NEA Workshop OECD (1979b),	to: ca. 1.8
p. 87	Source: AECL-7812 (1983), p. 34
Argillite	Bentonite
Poisson's ratio	Wyoming
ranges from: 0.30	Swelling pressure (MPa)
to: -	ranges from: ca. 0
Source: Proc NEA Workshop OECD (1979b),	to: ca. 2.2
p. 87	Source: AECL-7812 (1983), p. 34
Argillite	Bentonite
Tensile strength (MPa)	Young's modulus (MPa)
ranges from: 3.5	ranges from: 300
to: -	to: -
Source: Proc NEA Workshop OECD (1979b),	Source: ONWI-486 (1983), p. 63
p. 81	
Argillite (a)	Bentonite (a)
Young's modulus (GPa)	Oregon
ranges from: 3.7 (3.7 x 10(3) MPa)	Plasticity (liquid limit) (%)
to: 16 (MPa)	ranges from: 209.6
Source: Proc NEA Workshop OECD (1979b),	to: -
p. 83	Source: RHO-BWI-SA-80 (1981), p. 6
Argillite (b)	Bentonite (a)
Young's modulus (unconfined) (GPa)	Oregon
ranges from: 3.74 (3.7 x 10(3) MPa)	Plasticity (plastic index) (%)
to: -	ranges from: 168.58
Source: Proc NEA Workshop OECD (1979b),	to: -
p. 87	Source: RHO-BWI-SA-80 (1981), p. 6
Bentonite	Bentonite (a)
Wyoming	Oregon
Plasticity (liquid limit) (%)	Plasticity (plastic limit) (%)
ranges from: 553.1	ranges from: 41.0
to: -	to: -
Source: RHO-BWI-SA-80 (1981), p. 6	Source: RHO-BWI-SA-80 (1981), p. 6
Bentonite	Bentonite (a)
Wyoming	Oregon
Plasticity (plastic index) (%)	Plasticity (shrinkage limit) (%)
ranges from: 519.5	ranges from: 8.47
to: -	to: -
Source: RHO-BWI-SA-80 (1981), p. 6	Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (a)
 Swelling (%)
 ranges from: 5
 to: 20
 Source: KBS TEKNISK RAPPORT 9 (1977),
 p. 5

Bentonite (a)
 Swelling pressure (kPa)
 ranges from: 30 (0.03 MPa) (?)
 to: 110 (0.11 MPa) (?)
 Source: KBS TEKNISK RAPPORT 9 (1977),
 p. 6

Bentonite (b)
 Oregon
 Plasticity (liquid limit) (%)
 ranges from: 212.69
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (b)
 Oregon
 Plasticity (plastic index) (%)
 ranges from: 174.6
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (b)
 Oregon
 Plasticity (plastic limit) (%)
 ranges from: 38.1
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (b)
 Oregon
 Plasticity (shrinkage limit) (%)
 ranges from: 8.96
 to: -
 Source: RHO-BWI-SA-80 (1981), p. 6

Bentonite (b)
 Swelling (%)
 ranges from: 15
 to: 30
 Source: KBS TEKNISK RAPPORT 9 (1977),
 p. 6

Bentonite (b)
 Swelling pressure (kPa)
 ranges from: 30 (0.03 MPa) (?)
 to: 200 (0.20 MPa) (?)
 Source: KBS TEKNISK RAPPORT 9 (1977),
 p. 6

Bentonite (c)
 Swelling (%)
 ranges from: 1
 to: 50
 Source: ONWI-486 (1983), p. 49

Bentonite (c)
 Swelling pressure (MPa)
 ranges from: 0.7
 to: ca. 70
 Source: AECL-7812 (1983), p. 33

Bentonite (Ca)
 Swelling pressure (MPa)
 ranges from: 31.4
 to: -
 Source: ONWI-312 (1981), p. 31

Bentonite (Na)
 Wyoming
 Plasticity (liquid limit) (%)
 ranges from: 260
 to: -
 Source: AECL-7825 (1984), p. 12

Bentonite (Na) (a)
 Compressive strength (unconfined) (psi)
 ranges from: 55.5 (3.8 x 10(-1) MPa)
 to: -
 Source: ONWI-312 (1981), p. 22

Bentonite (Na) (a)
 Plasticity (liquid limit) (%)
 ranges from: 98
 to: -
 Source: AECL-7825 (1984), p. 12

Bentonite (Na) (a)
 Wyoming
 Plasticity (plastic limit) (%)
 ranges from: 50
 to: -
 Source: AECL-7825 (1984), p. 12

Bentonite (Na) (a)
 Wyoming
 Plasticity (plasticity index) (%)
 ranges from: 210
 to: -
 Source: AECL-7825 (1984), p. 12

Bentonite (Na) (a)
 Shear strength (kPa)
 ranges from: 1,600 (1.6 MPa)
 to: <15 (<1.5 x 10(-2) MPa)
 Source: KBS TEKNISK RAPPORT 74 (1978),
 p. 16

Bentonite (Na) (a)
 Swelling pressure (MPa)
 ranges from: >10
 to: -
 Source: ONWI-312 (1981), p. 15

Bentonite (Na) (b)
 Compressive strength (uniaxial) (MPa)
 ranges from: 8.9
 to: -
 Source: KBS TEKNISK RAPPORT 74 (1978),
 p. 14

Bentonite (Na) (b)
 Wyoming
 Plasticity (plastic limit) (%)
 ranges from: 19
 to: -
 Source: AECL-7825 (1984), p. 12

Bentonite (Na) (b)
Wyoming
Plasticity (plasticity index) (%)
ranges from: 79
to: -
Source: AECL-7825 (1984), p. 12

Bentonite (Na) (b)
Shear strength (MPa)
ranges from: 4.5
to: -
Source: KBS TEKNISK RAPPORT 74 (1978),
p. 14

Bentonite (Na) (b)
Swelling pressure (MPa)
ranges from: 57.7
to: -
Source: ONWI-312 (1981), p. 31

Bentonite (Na) (c)
Swelling pressure (MPa)
ranges from: 21.7
to: -
Source: ONWI-312 (1981), p. 31

Bentonite (Na) (d)
Swelling pressure (MPa)
ranges from: ca. 72
to: -
Source: RHO-BWI-SA-80 (1981), Fig. 6

Bentonite (Na) (e)
Wyoming
Swelling pressure (MPa)
ranges from: ca. 3
to: ca. 8
Source: AECL-7825 (1984), p. 16

Bentonite (Na) (f)
Wyoming
Swelling pressure (MPa)
ranges from: ca. 2
to: ca. 20
Source: AECL-7825 (1984), p. 16

Bentonite (Na) (g)
Wyoming
Swelling pressure (MPa)
ranges from: 1
to: 8
Source: KBS TEKNISK RAPPORT 74 (1978),
p. 6

Bentonite (Na) (h)
Wyoming
Swelling pressure (MPa)
ranges from: 2
to: 23
Source: ONWI-486 (1983), p. 51

Bentonite (Na) (i)
Wyoming
Swelling pressure (MPa)
ranges from: 3
to: 26
Source: ONWI-486 (1983), p. 51

Bentonite (Na) (j)
Wyoming
Swelling pressure (MPa)
ranges from: 3
to: 27
Source: ONWI-486 (1983), p. 51

Bentonite and Sand (a)
Oregon
Compressive strength (unconfined) (MPa)
ranges from: ca. 0
to: ca. 1.8
Source: RHO-BWI-SA-80 (1981), Fig. 4

Bentonite and Sand (a)
Oregon
Swelling pressure (MPa)
ranges from: ca. 0
to: ca. 1.8
Source: RHO-BWI-SA-80 (1981), Fig. 3

Bentonite and Sand (a)
Oregon
Young's modulus (MPa)
ranges from: ca. 55
to: ca. 80
Source: RHO-BWI-SA-80 (1981), Fig. 5

Bentonite and Sand (b)
Wyoming
Compressive strength (unconfined) (MPa)
ranges from: ca. 0
to: ca. 3
Source: RHO-BWI-SA-80 (1981), Fig. 4

Bentonite and Sand (b)
Wyoming
Swelling pressure (MPa)
ranges from: ca. 0
to: ca. 2.2
Source: RHO-BWI-SA-80 (1981), Fig. 3

Bentonite and Sand (b)
Wyoming
Young's modulus (MPa)
ranges from: ca. 45
to: 60
Source: RHO-BWI-SA-80 (1981), Fig. 5

Clay
Belgium
Cohesion (MPa)
ranges from: $1 \times 10(-1)$
to: 1
Source: Rad Waste Management and Nuclear
Fuel Cycle v.6 (1985), p. 54

Clay
Italy
Cohesion (MPa)
ranges from: $1 \times 10(-1)$
to: -
Source: Rad Waste Management and Nuclear
Fuel Cycle v.6 (1985), p. 54

Clay	Belgium	Clay	Belgium
	Friction angle (angle of shear resistance) (deg)		Plasticity (plastic limit) (%) ranges from: 26,5 to: -
	ranges from: 19 to: -		Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54			
Clay	Italy	Clay	England
	Friction angle (angle of shear resistance) (deg)		Plasticity (plastic limit) (%) ranges from: 26 to: -
	ranges from: 25 to: -		Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54			
Clay	Belgium	Clay	Hanford
	Plasticity (liquid limit) (%) ranges from: 77,5 to: -		Plasticity (plastic limit) (%) ranges from: 25,8 to: -
	Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54		Source: RHO-BWI-SA-80 (1981), p. 6
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54			
Clay	England	Clay	Hanford
	Plasticity (liquid limit) (%) ranges from: 55 to: -		Plasticity (plastic limit) (%) ranges from: 23,1 to: -
	Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54		Source: RHO-BWI-SA-80 (1981), p. 6
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54			
Clay	Hanford	Clay	Italy
	Plasticity (liquid limit) (%) ranges from: 44,6 to: -		Plasticity (plastic limit) (%) ranges from: 25 to: -
	Source: RHO-BWI-SA-80 (1981), p. 6		Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54
Source: RHO-BWI-SA-80 (1981), p. 6			
Clay	Hanford	Clay	Louisiana
	Plasticity (liquid limit) (%) ranges from: 63,9 to: -		Plasticity (plasticity index) (%) ranges from: 40 to: -
	Source: RHO-BWI-SA-80 (1981), p. 6		Source: ORNL/Sub/84-64794/1 (1985), p. 173
Source: RHO-BWI-SA-80 (1981), p. 6			
Clay	Italy	Clay	Hanford
	Plasticity (liquid limit) (%) ranges from: 50 to: -		Plasticity (shrinkage limit) (%) ranges from: 19,75 to: -
	Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54		Source: RHO-BWI-SA-80 (1981), p. 6
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54			
Clay	Hanford	Clay	Belgium
	Plasticity (plastic index) (%) ranges from: 18,8 to: -		Shear strength (undrained) (MPa) ranges from: 0,6 to: -
	Source: RHO-BWI-SA-80 (1981), p. 6		Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54
Source: RHO-BWI-SA-80 (1981), p. 6			
Clay	Hanford	Clay	England
	Plasticity (plastic index) (%) ranges from: 40,8 to: -		Shear strength (undrained) (MPa) ranges from: 1,2 to: -
	Source: RHO-BWI-SA-80 (1981), p. 6		Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54
Source: RHO-BWI-SA-80 (1981), p. 6			

Clay	Italy	Illite (Ca) (a)
		Filthian, IL
Shear strength (undrained) (MPa)		Plasticity (plastic limit) (%)
ranges from: 1.5		ranges from: 40
to: -		to: -
Source: Rad Waste Management and Nuclear		Source: ONWI-486 (1983), p. 43
Fuel Cycle v.6 (1985), p. 54		
Clay	Louisiana	Illite (Ca) (b)
		Grundy County, IL
Strength (MPa)		Plasticity (liquid limit) (%)
ranges from: 0.19		ranges from: 100
to: -		to: -
Source: ORNL/Sub/84-64794/1 (1985),		Source: ONWI-486 (1983), p. 43
p. 173		
Clay	Belgium	Illite (Ca) (b)
		Grundy County, IL
Young's modulus (elastic modulus) (MPa)		Plasticity (plastic limit) (%)
ranges from: 170		ranges from: 42
to: -		to: -
Source: Rad Waste Management and Nuclear		Source: ONWI-486 (1983), p. 43
Fuel Cycle v.6 (1985), p. 54		
Clay	Italy	Illite (Na) (a)
		Friction angle (residual) (tan)
Young's modulus (elastic modulus) (MPa)		ranges from: 0.3
ranges from: 300		to: 0.7
to: -		Source: ONWI-486 (1983), p. 47
Source: Rad Waste Management and Nuclear		
Fuel Cycle v.6 (1985), p. 54		
Illite		Illite (Na) (b)
		Friction angle (residual) (tan)
Plasticity (plasticity index) (%)		ranges from: 0.47
ranges from: 0		to: 0.7
to: 90		Source: ONWI-486 (1983), p. 47
Source: ONWI-486 (1983), p. 45		
Illite		Illite and Bentonite (a)
		Swelling (%)
Swelling (%)		ranges from: 1
ranges from: <2		to: 54
to: 20		Source: ONWI-486 (1983), p. 49
Source: ONWI-486 (1983), p. 49		
Illite (Ca)		Illite and Bentonite (b)
		Swelling (%)
Jackson County, OH		ranges from: <2
Plasticity (liquid limit) (%)		to: 30
ranges from: 69		Source: ONWI-486 (1983), p. 49
to: -		
Source: ONWI-486 (1983), p. 43		
Illite (Ca)		Illite and Kaolinite
		Swelling (%)
Jackson County, OH		ranges from: <2
Plasticity (plastic limit) (%)		to: <10
ranges from: 36		Source: ONWI-486 (1983), p. 49
to: -		
Source: ONWI-486 (1983), p. 43		
Illite (Ca) (a)		Kaolinite
		Compressive strength (unconfined) (psi)
Filthian, IL		ranges from: 100.3 (6.9 x 10(-1) MPa)
Plasticity (liquid limit) (%)		to: -
ranges from: 90		Source: ONWI-312 (1981), p. 22
to: -		
Source: ONWI-486 (1983), p. 43		
Illite (Ca) (a)		Kaolinite
		Friction angle (residual) (tan)
Filthian, IL		ranges from: 0.27
Plasticity (liquid limit) (%)		to: 0.7
ranges from: 90		Source: ONWI-486 (1983), p. 47
to: -		
Source: ONWI-486 (1983), p. 43		
Illite		Kaolinite
		Plasticity (plasticity index) (%)
		ranges from: 0
		to: 35
		Source: ONWI-486 (1983), p. 45

Kaolinite
Swelling (%)
ranges from: <2
to: 4
Source: ONWI-486 (1983), p. 49

Kaolinite (Ca)
 Anna, IL
Plasticity (liquid limit) (%)
 ranges from: 73
 to: -
 Source: ONWI-486 (1983), p. 43

Kaolinite (Ca)
 Dry Branch, GA
 Plasticity (liquid limit) (%)
 ranges from: 34
 to: -
 Source: ONWI-486 (1983), p. 43

Kaolinite (Ca)
Anna, IL
Plasticity (plastic limit) (%)
ranges from: 36
to: -
Source: ONWI-486 (1983), p. 43

Kaolinite (Ca)
 Dry Branch, GA
 Plasticity (plastic limit) (%)
 ranges from: 26
 to -
 Source: ONWI-486 (1983), p. 43

Kaolinite and Bentonite
Swelling (%)
ranges from: 2
to: 35
Source: ONNL-486 (1983), p. 49

Oil Shales
Compressive strength (MPa)
ranges from: 35
to: 138
Source: ORNL/Sub/84-64794/1 (1985),
p. 348

Oli Shales
Compressive strength (MPa)
ranges from: 138
to: 172
Source: ORNL/Sub/84-64794/1 (1985),
p. 348

011 Shales
Poisson's ratio
ranges from: 0.2
to: 0.3
Source: ORNL/Sub/84-64794/1 (1985),
p. 348

011 Shales
Poisson's ratio
ranges from: 0.15
to: 0.20
Source: ORNL/Sub/84-64794/1 (1985),
p. 348

Oil Shales
Young's modulus (MPa)
ranges from: 7,000 (7 x 10(3))
 17,500 (1.75 x 10(4))
Sor. /Sub/84-64794/1 (1985),
 48

Off. Shal.
Young's .Pa)
ran >21,000 (>2.1 x 10(4))
to: -
Source: ORNL/Sub/84-54794/1 (1985),
p. 348

Shale
Bulk modulus (psi)
ranges from: 77.8×10^3 (5.4 $\times 10^2$)
MPa)
to: -
Source: YOHMI/TM36/6 (1978), p. 3-24

Shale
Ohio
Cohesion (psi)
ranges from: 5,900 (4.1 x 10(1) MPa)
to: -

Shale **Indiana**
Compressive strength (MPa)
ranges from: 11
 to: 115
Source: ORNL/Sub/84-64794/1 (1985),
p. 60

Shale	Great Plains
Compressive strength (psi)	Plasticity (plasticity index) (%)
ranges from: $8.5 \times 10(3)$ (5.9 x 10(1) MPa)	ranges from: 30 to: 110
to: -	Source: ORNL/Sub/84-64794/1 (1985), p. 293
Source: Y/OWI/TM36/6 (1978), p. 6-3	
Shale	Shale
New Mexico	Polsson's ratio
Compressive strength (psi)	ranges from: 0.2
ranges from: 1,000 (6.9 MPa) to: 6,000 ($4.1 \times 10(1)$ MPa)	to: -
Source: Y/OWI/TM36/6 (1978), p. 8-5	Source: Y/OWI/TM36/6 (1978), p. 3-24
Shale	Shale
New Mexico	Ohio
Compressive strength (psi)	Polsson's ratio
ranges from: 1,000 (6.9 MPa) to: 8,000 ($5.5 \times 10(1)$ MPa)	ranges from: 0.1 to: -
Source: Y/OWI/TM36/6 (1978), p. 8-2	Source: Y/OWI/TM36/6 (1978), p. 5-14
Shale	Shale
Ohio	Ohio
Compressive strength (uniaxial) (MPa)	Polsson's ratio
ranges from: 13.8 to: -	ranges from: 0.25 to: -
Source: ORNL/Sub/84-64794/1 (1985), p. 108	Source: Y/OWI/TM36/6 (1978), p. 4-12
Shale	Shale
Ohio	Ratio of strength to overburden stress
Compressive strength (uniaxial) (psi)	ranges from: 1.3 to: 6.0
ranges from: $1 \times 10(4)$ (6.9 x 10(1) MPa)	Source: ORNL-6241/V1 (In preparation) p. 53
to: -	
Source: Y/OWI/TM36/6 (1978), p. 5-14	
Shale	Shale
Ohio	Shear modulus (psi)
Compressive strength (uniaxial) (psi)	ranges from: $6.2 \times 10(5)$ (4.3 x 10(3) MPa)
ranges from: $2 \times 10(3)$ ($1.4 \times 10(1)$ MPa)	to: -
to: -	Source: Y/OWI/TM36/6 (1978), p. 7-8
Source: Y/OWI/TM36/6 (1978), p. 4-12	
Shale	Shale
Ohio	Shear modulus (psi)
Friction angle (deg)	ranges from: $58.3 \times 10(3)$ (4 x 10(2) MPa)
ranges from: 23.4 to: -	to: -
Source: Y/OWI/TM36/6 (1978), p. 5-14	Source: Y/OWI/TM36/6 (1978), p. 3-24
Shale	Shale
Ohio	Ohio
Friction angle (deg)	Shear modulus (psi)
ranges from: 22 to: -	ranges from: $6.8 \times 10(5)$ (4.7 x 10(3) MPa)
Source: Y/OWI/TM36/6 (1978), p. 4-12	to: -
	Source: Y/OWI/TM36/6 (1978), p. 5-14
Shale	Shale
Montana	Ohio
Plasticity (liquidity index)	Shear modulus (psi)
ranges from: -0.11 to: -	ranges from: $6.8 \times 10(4)$ (4.7 x 10(2) MPa)
Source: Y/OWI/TM36/6 (1978), p. 6-1	to: -
	Source: Y/OWI/TM36/6 (1978), p. 4-12

Shale	Shale (a)
Canada	Cohesion (psi)
Swelling (potential) (%)	ranges from: 0 (0 MPa)
ranges from: 2 to: 20	to: 4,250 ($3 \times 10(1)$ MPa)
Source: ORNL/Sub/84-64794/1 (1985), p. 293	Source: Y/OWI/TM36/6 (1978), p. 2-2
Shale	Shale (a)
Great Plains	Montana
Swelling (potential) (%)	Compressive strength (kg/cm ²)
ranges from: 3 to: 5	ranges from: 122 ($1.2 \times 10(1)$ MPa)
Source: ORNL/Sub/84-64794/1 (1985), p. 293	to: 25 (2.5 MPa)
	Source: Y/OWI/TM36/6 (1978), p. 6-13
Shale	Shale (a)
Swelling pressure (MPa)	Compressive strength (uniaxial) (psi)
ranges from: 10 to: 0.5	ranges from: 70 ($4.8 \times 10(-1)$ MPa)
Source: KBS TEKNISK RAPPORT 74 (1978), p. 7	to: $3.7 \times 10(4)$ ($2.5 \times 10(2)$ MPa)
	Source: Y/OWI/TM36/6 (1978), p. 2-2
Shale	Shale (a)
Ohio	Compressive strength (uniaxial) (psi)
Tensile strength (psi)	ranges from: $2.1 \times 10(3)$ ($1.4 \times 10(1)$ MPa)
ranges from: 200 to: -	to: -
Source: Y/OWI/TM36/6 (1978), p. 5-14	Source: Y/OWI/TM36/6 (1978), p. 3-24
Shale	Shale (a)
Young's modulus (elastic modulus) (psi $\times 10(6)$)	Friction angle (deg)
ranges from: 1.48 to: -	ranges from: 4.2 to: 56
Source: Y/OWI/TM36/6 (1978), p. 6-3	Source: Y/OWI/TM36/6 (1978), p. 2-2
Shale	Shale (a)
Great Plains	Friction angle (deg)
Young's modulus (elastic modulus) (psi $\times 10(6)$)	ranges from: 5.3 to: -
ranges from: 0.02 to: 0.014	Source: Y/OWI/TM36/6 (1978), p. 3-24
Source: ORNL/Sub/84-64794/1 (1985), p. 293	
Shale	Shale (a)
Young's modulus (psi)	Great Plains
ranges from: $1.4 \times 10(5)$ to: -	Plasticity (liquid limit) (%)
MPa	ranges from: 36 to: 113
Source: Y/OWI/TM36/6 (1978), p. 3-24	Source: ORNL/Sub/84-64794/1 (1985), p. 291
Shale	Shale (a)
Ohio	Great Plains
Young's modulus (psi)	Plasticity (plastic limit) (%)
ranges from: $1.5 \times 10(6)$ to: -	ranges from: 20 to: 62
MPa	Source: ORNL/Sub/84-64794/1 (1985), p. 291
Source: Y/OWI/TM36/6 (1978), p. 5-14	
Shale	Shale (a)
Ohio	Poisson's ratio
Young's modulus (psi)	ranges from: 0.03 to: 0.50
ranges from: $1.7 \times 10(5)$ to: -	Source: Y/OWI/TM36/6 (1978), p. 2-2
MPa	
Source: Y/OWI/TM36/6 (1978), p. 4-12	
Shale	Shale (a)
Ohio	Tensile strength (psi)
Young's modulus (psi)	ranges from: 0 (0 MPa) (?)
ranges from: $1.7 \times 10(5)$ to: -	to: 1,540 ($1.1 \times 10(1)$ MPa)
MPa	Source: Y/OWI/TM36/6 (1978), p. 2-2
Source: Y/OWI/TM36/6 (1978), p. 4-12	

Shale (a)
Young's modulus (MPa)
 ranges from: 10
 to: 32
 Source: ORNL-6241/V1 (in preparation)
 p. 47

Shale (b)
Cohesion (psi)
 ranges from: $6 \times 10(3)$ $(4.1 \times 10(1)$
 MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (b)
Montana
Compressive strength (kg/cm²)
 ranges from: 25 (2.5 MPa)
 to: 55 (5.4 MPa)
 Source: Y/OWI/TM36/6 (1978), p. 6-13

Shale (b)
Great Plains
Compressive strength (psi)
 ranges from: 70 ($4.8 \times 10(-1)$ MPa)
 to: 2,530 ($1.7 \times 10(1)$ MPa)
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Shale (b)
Compressive strength (uniaxial) (psi)
 ranges from: $1 \times 10(4)$ ($6.9 \times 10(1)$
 MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (b)
Friction angle (deg)
 ranges from: 26
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (b)
Great Plains
Friction angle (internal) (deg)
 ranges from: 8
 to: 25
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Shale (b)
Great Plains
Plasticity (liquid limit) (%)
 ranges from: 55
 to: 202
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Shale (b)
Great Plains
Plasticity (plastic limit %)
 ranges from: 22
 to: 39
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Shale (b)
Poisson's ratio
 ranges from: 0.15
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (b)
Tensile strength (psi)
 ranges from: 200 (1.4 MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (b)
Young's modulus (MPa)
 ranges from: 10
 to: 32
 Source: ORNL-6241/V1 (in preparation)
 p. 47

Shale (c)
Cohesion (psi)
 ranges from: 206 (1.4 MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Shale (c)
Friction angle (dilation angle) (deg)
 ranges from: +5
 to: -5
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Shale (c)
Ohio
Tensile strength (MPa)
 ranges from: 0.34
 to: -
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 108

Shale (c)
Young's modulus (psi)
 ranges from: $2 \times 10(3)$ ($1.4 \times 10(1)$
 MPa)
 to: $6.4 \times 10(6)$ ($4.4 \times 10(4)$
 MPa)
 Source: Y/OWI/TM36/6 (1978), p. 2-2

Shale (d)
Great Plains
Cohesion (psi)
 ranges from: 2 ($1.4 \times 10(-2)$ MPa)
 to: 30 ($2.1 \times 10(-1)$ MPa)
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Shale (d)
Friction angle (internal) (deg)
 ranges from: 14.2
 to: 51.0
 Source: ORNL-6241/V1 (in preparation)
 p. 47

Shale (d)
Ohio
Tensile strength (psi)
 ranges from: 50 ($3.4 \times 10(-1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 4-12

Shale (d)

Young's modulus (psi)
 ranges from: $1.6 \times 10(6)$ ($1.1 \times 10(4)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (e)

Tensile strength (psi)
 ranges from: 50 ($3.4 \times 10(-1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Shales

Bulk modulus ($\text{Pa} \times 10(10)$)
 ranges from: ca. 50 (ca. $5 \times 10(5)$ MPa)
 to: ca. 200 (ca. $2 \times 10(6)$ MPa)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Shales

Western Ohio
 Compressive strength (MPa)
 ranges from: 20
 to: 32
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 71

Shales

Various
 Tensile strength (psi)
 ranges from: <100 ($<6.9 \times 10(-1)$ MPa)
 to: 1,538 ($1.1 \times 10(1)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. A-7

Shales (a)

Compressive strength (unconfined) (MPa)
 ranges from: 25.2
 to: 113.6
 Source: ORNL-6241/V3 (in preparation)
 p. 110

Shales (a)

Poisson's ratio
 ranges from: 0.11
 to: 0.31
 Source: ORNL-6241/V3 (in preparation)
 p. 110

Shales (a)

Shear modulus ($\text{Pa} \times 10(10)$)
 ranges from: 0.1 ($1 \times 10(3)$ MPa)
 to: 100 ($1 \times 10(6)$ MPa)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Shales (a)

Young's modulus (GPa)
 ranges from: 9.9 ($9.9 \times 10(3)$ MPa)
 to: 31.7 ($3.17 \times 10(4)$ MPa)
 Source: ORNL-6241/V3 (in preparation)
 p. 110

Shales (b)

Various
 Compressive strength (unconfined) (psi)
 ranges from: <100 ($<6.9 \times 10(-1)$ MPa)
 to: $3.7 \times 10(4)$ ($2.5 \times 10(2)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. A-4,5,6

Shales (b)

Various
 Poisson's ratio
 ranges from: 0.03
 to: 0.77
 Source: Y/OWI/TM36/6 (1978), p. A-11

Shales (b)

Various
 Shear modulus (psi)
 ranges from: $1.7 \times 10(6)$ ($1.2 \times 10(4)$ MPa)
 to: $3.6 \times 10(6)$ ($2.5 \times 10(4)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. A-10

Shales (b)

Young's modulus ($\text{Pa} \times 10(10)$)
 ranges from: 1 ($1 \times 10(4)$ MPa)
 to: 500 ($5 \times 10(6)$ MPa)
 Source: ORNL-6241/V2 (in preparation)
 p. 199

Shales (c)

Various
 Young's modulus (psi)
 ranges from: $0.0020 \times 10(6)$ ($1.4 \times 10(1)$ MPa)
 to: $15.0 \times 10(6)$ ($1 \times 10(5)$ MPa)
 Source: Y/OWI/TM36/6 (1978), p. A-8,9

Shales, Mudstones, Siltstones

Various
 Plasticity (liquid limit) (%)
 ranges from: 17.8
 to: 224
 Source: Y/OWI/TM36/6 (1978), p. 6-20 to 6-26

Shales, Mudstones, Siltstones

Various
 Plasticity (plastic limit) (%)
 ranges from: 16.0
 to: 45.5
 Source: Y/OWI/TM36/6 (1978), p. 6-20 to 6-26

Shales, Mudstones, Siltstones

Various
 Plasticity (plasticity index) (%)
 ranges from: 1.8
 to: 192
 Source: Y/OWI/TM36/6 (1978), p. 6-20 to 6-26

Smectite (Ca)

Belle Fourche, SD
 Plasticity (liquid limit) (%)
 ranges from: 177
 to: -
 Source: ONWI-486 (1983), p. 43

Smectite (Ca)
Cheto, AZ
Plasticity (liquid limit) (%)
ranges from: 155
to: -
Source: ONWI-486 (1983), p. 43

Smectite (Ca)
Omsted, IL
Plasticity (liquid limit) (%)
ranges from: 123
to: -
Source: ONWI-486 (1983), p. 43

Smectite (Ca)
Pontotoc, MS
Plasticity (liquid limit) (%)
ranges from: 166
to: -
Source: ONWI-486 (1983), p. 43

Smectite (Ca)
Belle Fourche, SD
Plasticity (plastic limit) (%)
ranges from: 63
to: -
Source: ONWI-486 (1983), p. 43

Smectite (Ca)
Cheto, AZ
Plasticity (plastic limit) (%)
ranges from: 65
to: -
Source: ONWI-486 (1983), p. 43

Smectite (Ca)
Omsted, IL
Plasticity (plastic limit) (%)
ranges from: 79
to: -
Source: ONWI-486 (1983), p. 43

Smectite (Ca)
Pontotoc, MS
Plasticity (plastic limit) (%)
ranges from: 65
to: -
Source: ONWI-486 (1983), p. 43

Smectite (Na)
Plasticity (plasticity index) (%)
ranges from: 0
to: 500
Source: ONWI-486 (1983), p. 45

Smectite (Na) (a)
Friction angle (residual) (tan)
ranges from: 0.09
to: 0.7
Source: ONWI-486 (1983), p. 47

Smectite (Na) (b)
Friction angle (residual) (tan)
ranges from: 0.18
to: 0.7
Source: ONWI-486 (1983), p. 47

Smectite (Na), Kaolinite, Sand Mixtures (a)
Osage, NY
Compressive strength (psi)
ranges from: 76.5 ($5.3 \times 10(-1)$ MPa)
to: 541.0 (3.7 MPa)
Source: ONWI-312 (1981), p. 24

Smectite (Na), Kaolinite, Sand Mixtures (b)
Osage, NY
Compressive strength (psi)
ranges from: 9.1 ($6.3 \times 10(-2)$ MPa)
to: 85.5 ($5.9 \times 10(-1)$ MPa)
Source: ONWI-312 (1981), p. 24

Argillite
Coefficient of linear expansion (deg C(-1)) (K(-1))
 ranges from: $8 \times 10(-6)$
 to: $15 \times 10(-6)$
 Source: Proc NEA Workshop OECD (1979b), p. 77

Argillite (a)
Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 ranges from: ca. 1.80
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Argillite (b)
Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
 ranges from: ca. 1.48
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 87

Argillite (c)
Nevada
Thermal conductivity (W/m-K)
 ranges from: 1.28
 to: 2.7
 Source: ORNL-6241/V3 (in preparation)
 p. 341, 342

Bentonite (a)
Heat conductivity (W/m-deg C) (thermal conductivity) (W/m-K)
 ranges from: 0.5
 to: 2.0
 Source: KBS TEKNISK RAPPORT 9 (1977), p. 8

Bentonite (b)
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: ca. 0.75
 to: -
 Source: Proc NEA Workshop OECD (1979b), p. 148

Bentonite (c)
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.7
 to: 3.0
 Source: Proc NEA Workshop OECD (1981), p. 342

Bentonite (Ca)
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.71
 to: 1.10
 Source: PNL-4452 UC-70 (1983), p. 20

Bentonite (d)
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.5
 to: 1.0
 Source: Proc NEA Workshop OECD (1981), p. 342

Bentonite (e)
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.9
 to: 1.3
 Source: ONWI-486 (1983), p. 63

Bentonite (f)
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 1
 to: 3.5
 Source: ONWI-486 (1983), p. 63

Bentonite (g)
Wyoming
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: ca. 0.0
 to: ca. 1.2
 Source: Proc NEA Workshop OECD (1981), p. 334

Bentonite (h)
Wyoming
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.78
 to: -
 Source: ONWI-486 (1983), p. 61

Bentonite (Na)
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.52
 to: 0.96
 Source: PNL-4452 UC-70 (1983), p. 20

Bentonite (Na)
Thermal diffusivity (cm²)/s x 10(3))
 ranges from: 3.03 (3.03 x 10(-7)
 m²/s)
 to: 3.47 (3.47 x 10(-7)
 m²/s)
 Source: PNL-4452 UC-70 (1983), p. 18, 19

Bentonite and Crushed Granite (a)
Wyoming
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 2.7
 to: 0.8
 Source: Proc NEA Workshop OECD (1981), p. 334

Bentonite and Crushed Granite (b)
Wyoming
Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: ca. 0.6
 to: ca. 1.5
 Source: Proc NEA Workshop OECD (1981), p. 334

Bentonite and Salt (a)
Thermal conductivity (W/m-K)
 ranges from: 1.12
 to: 0.99
 Source: ONWI-486 (1983), p. 53

Bentonite and Salt (b)
Thermal conductivity (W/m-K)
 ranges from: 1.01
 to: 1.12
 Source: ONWI-486 (1983), p. 53

Bentonite and Sand (a)	Clay
Thermal conductivity (W/m-deg C) (W/m-K)	Italy
ranges from: 0.5 to: 2.0	Thermal diffusivity (m ² /s)
Source: ONWI-486 (1983), p. 63	ranges from: 7.8 x 10(-7) to: -
Bentonite and Sand (b)	Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54
Thermal conductivity (W/m-K)	Clay (a)
ranges from: 0.58-0.80 to: 1.06-1.17	Belgium
Source: ONWI-486 (1983), p. 53	Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
Clay	ranges from: ca. 0.3 to: -
Belgium	Source: Proc NEA Workshop OECD (1979b), p. 87
Specific heat (J/Kg-K) (specific heat capacity)	Clay (b)
ranges from: 9.21 x 10(2) to: -	Belgium
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54	Thermal conductivity (W/m-K)
Clay	ranges from: 1.5 to: -
Italy	Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54
Specific heat (J/Kg-K) (specific heat capacity)	Clayey Sandstones
ranges from: 9.21 x 10(2) to: -	Heat conductivity (millical/cm-s-deg C) (thermal conductivity)
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54	ranges from: 2.5 (1.05 W/m-K) to: -
Clay	Source: Y/ONWI/SUB-7009/1 (1976), p. 23
S. Paolo mine	Hectorite
Thermal conductivity (W/m-deg C) (W/m-K)	Thermal conductivity (W/m-deg C) (W/m-K)
ranges from: 0.014 (1.4 W/m-K) to: 0.016 (1.6 W/m-K)	ranges from: 0.5 to: 2 to 3
Source: ORNL-tr-5110 (1981), p. 12	Source: ONWI-312 (1981), p. 18
Clay	Illite (a)
England	Thermal conductivity (W/m-deg C) (W/m-K)
Thermal conductivity (W/m-K)	ranges from: ca. 0.6 to: ca. 1.6
ranges from: 1.56 to: -	Source: Proc NEA Workshop OECD (1981), p. 336
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54	Illite (b)
Clay	Thermal conductivity (W/m-deg C) (W/m-K)
Italy	ranges from: 1.4 to: 4.0
Thermal conductivity (W/m-K)	Source: Proc NEA Workshop OECD (1981), p. 342
ranges from: 1.5 to: -	Illite (c)
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54	Thermal conductivity (W/m-deg C) (W/m-K)
Clay	ranges from: 0.8 to: 1.8
S. Paolo mine	Source: Proc NEA Workshop OECD (1981), p. 342
Thermal diffusivity (cm ² /h)	Illite and Crushed Granite
ranges from: 20 (5.56 x 10(-7) m ² /s) to: -	Thermal conductivity (W/m-deg C) (W/m-K)
Source: ORNL-tr-5110 (1981), p. 12	ranges from: ca. 0.9 to: ca. 1.9
Clay	Source: Proc NEA Workshop OECD (1981), p. 336
Belgium	
Thermal diffusivity (m ² /s)	
ranges from: 8.1 x 10(-7) to: -	
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54	

Kaolinite (a)	Shale (a)
Thermal conductivity (W/m-deg C) (W/m-K)	Coefficient of linear thermal expansion (deg F(-1))
ranges from: 1.7 to: 3.5	ranges from: $4 \times 10(-6)$ ($2.2 \times 10(-6)$ K(-1))
Source: Proc NEA Workshop OECD (1981), p. 342	to: - Source: Y/OWI/TM36/6 (1978), p. 2-2
Kaolinite (b)	Shale (a)
Thermal conductivity (W/m-deg C) (W/m-K)	Heat capacity (J/Kg-K)
ranges from: 0.9 to: 2.0	ranges from: $5.5 \times 10(2)$ to: $1.042 \times 10(3)$
Source: Proc NEA Workshop OECD (1981), p. 342	Source: ORNL-6241/V1 (in preparation) p. 40
Kaolinite and Crushed Granite	Shale (a)
Thermal conductivity (W/m-deg C) (W/m-K)	England
ranges from: 3.4 to: 2.3	Thermal conductivity (millical/cm-s-deg C)
Source: Proc NEA Workshop OECD (1981), p. 334	ranges from: 2.2 ($9.2 \times 10(-1)$ W/m-K) to: 5.3 (2.22 W/m-K)
Shale	Source: Y/OWI/SUB-7009/1 (1976), p. 26
Heat capacity (BTU/lb-deg F)	Shale (b)
ranges from: 0.20 ($8.4 \times 10(2)$ J/Kg-K)	Coefficient of linear thermal expansion (horizontal) (deg F(-1))
to: -	ranges from: $4.5 \times 10(-6)$ ($2.5 \times 10(-6)$ K(-1))
Source: Y/OWI/TM36/6 (1978), p. 7-8	to: - Source: Y/OWI/TM36/6 (1978), p. 7-8
Shale	Shale (b)
Thermal conductivity (W/m-K)	Heat capacity (J/Kg-K)
ranges from: 1.42 to: 1.94	ranges from: $7.12 \times 10(2)$ to: $1.170 \times 10(3)$
Source: ORNL-6241/V3 (in preparation) p. 341	Source: ORNL-6241/V3 (in preparation) p. 345
Shale	Shale (b)
Kansas	Thermal conductivity (horizontal) (BTU/hr-ft-deg F)
Thermal conductivity (W/m-K)	ranges from: 1.1 (1.9 W/m-K)
ranges from: 0.7 to: 4.3	to: - Source: Y/OWI/TM36/6 (1978), p. 7-8
Source: ORNL-6241/V3 (in preparation) p. 343	Shale (b)
Shale	Coefficient of linear thermal expansion (vertical) (deg F(-1))
Michigan	ranges from: $9 \times 10(-6)$ ($5 \times 10(-6)$ K(-1))
Thermal conductivity (W/m-K)	to: - Source: Y/OWI/TM36/6 (1978), p. 7-8
ranges from: 2.64 to: -	Shale (c)
Source: ORNL-6241/V3 (in preparation) p. 341	Coefficient of linear thermal expansion (vertical) (deg F(-1))
Shale	ranges from: $9 \times 10(-6)$ ($5 \times 10(-6)$ K(-1))
Orange Free State	to: - Source: Y/OWI/TM36/6 (1978), p. 7-8
Thermal conductivity (W/m-K)	Shale (c)
ranges from: 1.97 to: 2.89	Specific heat (J/Kg-deg C) (specific heat capacity) (J/Kg-K)
Source: ORNL-6241/V3 (in preparation) p. 341	ranges from: $7.96 \times 10(2)$ to: - Source: ORNL-6241/V2 (in preparation) p. 57
Shale	Shale (c)
South Africa	Thermal conductivity (horizontal) (J/s m-deg C) (W/m-K)
Thermal conductivity (W/m-K)	ranges from: 1.89 to: - Source: ORNL-6241/V2 (in preparation) p. 99
ranges from: 2.76 to: -	
Source: ORNL-6241/V3 (in preparation) p. 343	

Shale (d)
Thermal conductivity (horizontal) (W/m-K)
 ranges from: 1.52
 to: 2.26
 Source: ORNL-6241/V1 (In preparation)
 p. 40

Shale (e)
Thermal conductivity (vertical) (BTU/hr-ft-deg F)
 ranges from: 0.8 (1.4 W/m-K)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 7-8

Shale (f)
Thermal conductivity (vertical) (W/m-K)
 ranges from: 1.21
 to: 1.57
 Source: ORNL-6241/V1 (In preparation)
 p. 40

Shale (g)
Thermal conductivity ratio (vertical/horizontal)
 ranges from: 0.76
 to: -
 Source: ORNL-6241/V2 (In preparation)
 p. 99

Shale (h)
 England
Thermal conductivity (millical/cm-s-deg C)
 ranges from: 3.0 (1.26 W/m-K)
 to: 4.3 (1.80 W/m-K)
 Source: Y/OWI/SUB-7009/1 (1976), p. 26

Shale (i)
 England
Thermal conductivity (W/m-K)
 ranges from: 1.26
 to: 1.80
 Source: ORNL-6241/V3 (In preparation)
 p. 341

Shale (j)
 Massachusetts
Thermal conductivity (W/m-K)
 ranges from: 1.62
 to: -
 Source: ORNL-6241/V3 (In preparation)
 p. 341

Shale (k)
 Sunderland, MA
Thermal conductivity (millical/cm-s-deg C)
 ranges from: 3.87 (1.62 W/m-K)
 to: 4.25 (1.78 W/m-K)
 Source: Y/OWI/SUB-7009/1 (1976), p. 28

Shale (l)
Thermal conductivity (matrix) (W/m-deg C)
(W/m-K)
 ranges from: 0.7 to 2.1
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 87

Shale (m)
Thermal conductivity (W/m-K)
 ranges from: 0.715
 to: 2.20
 Source: ORNL-6241/V3 (In preparation)
 p. 340

Shale (n)
Thermal conductivity (W/m-K)
 ranges from: 1.38
 to: 1.9
 Source: ORNL-6241/V3 (In preparation)
 p. 341

Shales
Thermal conductivity (vertical) (W/m-K)
 ranges from: 1.21
 to: 1.57
 Source: ORNL-6241/V3 (In preparation)
 p. 115

Shales
 California
Thermal conductivity (W/m-K)
 ranges from: 0.99 +/- 0.3
 to: 1.63 +/- 0.3
 Source: ORNL-6241/V3 (In preparation)
 p. 340

Shales
California
Coefficient of linear thermal expansion (K(-1))
 ranges from: $2.5 \times 10(-6)$
 to: $15.8 \times 10(-6)$
 Source: ORNL-6241/V3 (In preparation)
 p. 345

Shales (a)
Heat capacity (BTU/lb-deg F)
 ranges from: 0.16 ($6.7 \times 10(2)$ J/Kg-K)
 to: 0.20 ($8.4 \times 10(2)$ J/Kg-K)
 Source: Y/OWI/TM36/6 (1978), p. A-19

Shales (a)
Thermal conductivity (horizontal) (W/m-K)
 ranges from: ca. 1.60
 to: ca. 2.20
 Source: ORNL-6241/V3 (In preparation)
 p. 117

Shales (b)
Coefficient of thermal expansion (K(-1))
 ranges from: $2.9 \times 10(-6)$
 to: $12.9 \times 10(-6)$
 Source: ORNL-6241/V1 (In preparation)
 p. 47

Shales (b)
Specific heat (J/Kg-K) (specific heat capacity)
 ranges from: $5.50 \times 10(2)$
 to: $1.042 \times 10(3)$
 Source: ORNL-6241/V3 (In preparation)
 p. 115

Shales (b)

Various

Thermal conductivity (BTU/ft-hr-deg F)
 ranges from: 0.34 (5.9 x 10(-1) W/m-K)
 to: 1.77 (3.1 W/m-K)
 Source: Y/OWI/TM36/6 (1978), p. A-18

Silt/Clay Soil (a)

Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.8
 to: 2.0
 Source: ONWI-486 (1983), p. 54

Silt/Clay Soil (b)

Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.4
 to: 0.85
 Source: ONWI-486 (1983), p. 54

Silt/Clay Soil (c)

Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.5
 to: 1.1
 Source: ONWI-486 (1983), p. 54

Silt/Clay Soil (d)

Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.6
 to: 1.3
 Source: ONWI-486 (1983), p. 54

Silt/Clay Soil (e)

Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.7
 to: 1.5
 Source: ONWI-486 (1983), p. 54

Silt/Clay Soil (f)

Thermal conductivity (W/m-deg C) (W/m-K)
 ranges from: 0.75
 to: 1.75
 Source: ONWI-486 (1983), p. 54

Soils

Bristol, VA

Thermal conductivity (Btu per hr-sq ft) (deg F per ft) (?)
 ranges from: 0.14
 to: 0.60
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Soils

Columbus, MS

Thermal conductivity (Btu per hr-sq ft) (deg F per ft) (?)
 ranges from: 0.28
 to: 2.28
 Source: Y/OWI/SUB-7009/1 (1976), p. 20

Soils

Thermal conductivity (k x 10(4)) (?)

ranges from: 3
 to: 5

Source: Y/OWI/SUB-7009/1 (1976), p. 19

Soils

Thermal conductivity (k x 10(4)) (?)

ranges from: 3-4
 to: 8-12

Source: Y/OWI/SUB-7009/1 (1976), p. 19

Soils

Bristol, VA

Thermal diffusivity (ft(2) per hr)
 ranges from: 0.0090 (2.3 x 10(-7)
 m(2)/s)
 to: 0.016 (4.13 x 10(-7)
 m(2)/s)

Source: Y/OWI/SUB-7009/1 (1976), p. 21

Soils

Columbus, MS

Thermal diffusivity (ft(2) per hr)
 ranges from: 0.016 (4.13 x 10(-7)
 m(2)/s)
 to: 0.046 (1.19 x 10(-7)
 m(2)/s)

Source: Y/OWI/SUB-7009/1 (1976), p. 21

Soils (a)

Cleveland, TN

Thermal conductivity (Btu per hr-sq ft) (deg F per ft) (?)
 ranges from: 0.15
 to: 0.94

Source: Y/OWI/SUB-7009/1 (1976), p. 20

Soils (a)

Cleveland, TN

Thermal diffusivity (ft(2) per hr)
 ranges from: 0.0115 (2.97 x 10(-7)
 m(2)/s)
 to: 0.022 (5.68 x 10(-7)
 m(2)/s)

Source: Y/OWI/SUB-7009/1 (1976), p. 21

Soils (b)

Murfreesboro, TN

Thermal conductivity (Btu per hr-sq ft) (deg F per ft) (?)
 ranges from: 0.21
 to: 0.84

Source: Y/OWI/SUB-7009/1 (1976), p. 20

Soils (b)

Murfreesboro, TN

Thermal diffusivity (ft(2) per hr)
 ranges from: 0.0145 (3.74 x 10(-7)
 m(2)/s)
 to: 0.0235 (6.06 x 10(-7)
 m(2)/s)

Source: Y/OWI/SUB-7009/1 (1976), p. 21

13.4 Appendix D. FORMATION NAMES

Boom Clay
Belgium
Ion exchange capacity (meq/100 g)
ranges from: ca. 20
to: -
Source: Proc NEA Workshop OECD (1979a),
p. 88

Boom Clay
Belgium
Sorption coefficient (Kd) (ml/g?)
ranges from: 0.87
to: 6.12
Source: Proc NEA Workshop OECD (1979a),
p. 97

Conasauga Shale
Sorption coefficient (Kd) (ml/g)
ranges from: 57
to: 100
Source: ONWI-486 (1983), p. 73

Conasauga Shale
Sorption coefficient (Kd) (ml/g)
ranges from: 41
to: 1340
Source: ONWI-486 (1983), p. 73

Dewey Lake Redbeds
Sorption coefficient (Kd) (ml/g)
ranges from: 200
to: $1.4 \times 10(4)$
Source: ONWI-486 (1983), p. 73

Eleana Argillite
Sorption coefficient (Kd) (ml/g)
ranges from: 0
to: $1 \times 10(5)$
Source: ONWI-486 (1983), p. 73

Antrim Shale Michigan	Blue Clay Italy
Density (bulk) (g/cm(3)) ranges from: 2.2 to: 2.8	Density (bulk) (kg/m(3)) ranges from: 2100 (2.100 g/cm(3)) to: -
Source: ORNL/Sub/84-64794/1 (1985), p. 96	Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54
Antrim Shale Michigan	Blue Clay Italy
Porosity (%) ranges from: 3 to: 10	Porosity (%) ranges from: 25 to: -
Source: ORNL-5703 (1983), p. 106	Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54
Antrim Shale Michigan	Boom Clay Belgium
Porosity (%) ranges from: 3 to: 10	Density (bulk) (kg/m(3)) ranges from: 2010 (2.010 g/cm(3)) to: -
Source: ORNL/Sub/84-64794/1 (1985), p. 98	Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54
Antrim Shale Michigan	Boom Clay Belgium
Specific surface (m(2)/g) ranges from: 0.05 to: 1.2	Porosity (%) ranges from: 38.5 to: -
Source: ORNL-5703 (1983), p. 109	Source: Rad Waste Management and Nuclear Fuel Cycle, v. 6 (1985), p. 54
Arnhem and Waynesville Fms Ohio	Chagrin Shale Ohio
Moisture content (natural) (%) ranges from: 2 to: -	Moisture content (natural) (%) ranges from: 4 to: -
Source: Y/OWI/TM36/6, p. 5-14	Source: Y/OWI/TM36/6, p. 4-12
Arnhem and Waynesville Fms Ohio	Chagrin Shale Ohio
Porosity (effective) (%) ranges from: 4 to: -	Porosity (rock mass) (%) ranges from: 8 to: -
Source: Y/OWI/TM36/6, p. 5-14	Source: Y/OWI/TM36/6, p. 4-12
Bearpaw Shale Montana	Chanute Shale Kansas
Density (dry) (average) (lbs/ft(3)) ranges from: 118 (1.890 g/cm(3)) to: -	Porosity (total) (units not stated) ranges from: 0.073 to: 0.106
Source: Y/OWI/TM36/6, p. 6-1	Source: ORNL-6241/V2 (in preparation) p. 52
Bearpaw Shale Montana	Chattanooga Shale Kentucky
Density (wet) (average) (pounds/ft(3)) ranges from: 135 (2.162 g/cm(3)) to: -	Porosity (total) (units not stated) ranges from: 0.074 to: 0.076
Source: Y/OWI/TM36/6, p. 6-1	Source: ORNL-6241/V2 (in preparation) p. 52
Bearpaw Shale Montana	Conasauga Shale Tennessee
Water content (average) (%) ranges from: 15 to: -	Porosity (%) ranges from: 0.5 to: 1.9
Source: Y/OWI/TM36/6, p. 6-1	Source: ORNL-6241/V2 (in preparation) p. 219

Conasauga Shale
Tennessee
Porosity (total) (units not stated)
ranges from: 0.005
to: 0.019
Source: ORNL-6241/V2 (in preparation)
p. 52

Eleana Argillite
Nevada
Density (bulk) (g/cm(3))
ranges from: 2.44
to: 2.71
Source: ORNL/Sub/84-64794/1 (1985),
p. 406

Eleana Argillite
Nevada
Moisture content (%)
ranges from: 2
to: 4
Source: ORNL/Sub/84-64794/1 (1985),
p. 406

Eleana Argillite
Nevada
Porosity (%)
ranges from: 8 to 16
to: 6 to 12
Source: ORNL/Sub/84-64794/1 (1985),
p. 406

Graneros, Greenhorn, Niobara and Pierre Shales
Black Hills
Density (bulk) (presumed g/cm(3))
ranges from: 1.559
to: 2.038
Source: Y/OWI/SUB-7009/1 (1976), p. 14

Green River Fm
Density (bulk) (presumed g/cm(3))
ranges from: 1.506
to: 2.37
Source: Y/OWI/SUB-7009/1 (1976), p. 13

Hamilton Shale
Missouri
Porosity (total) (units not stated)
ranges from: 0.113
to: -
Source: ORNL-6241/V2 (in preparation)
p. 52

Ireton Fm
Western Canada
Density (bulk) (presumed g/cm(3))
ranges from: 2.43
to: 2.71
Source: Y/OWI/SUB-7009/1 (1976), p. 17

Lewis Shale
New Mexico
Moisture content (%)
ranges from: 3.7
to: 6.2
Source: Y/OWI/TM36/6, p. 8-5

Mancos Fm
New Mexico
Moisture content (rock) (%)
ranges from: 3
to: 11
Source: Y/OWI/TM36/6, p. 8-3

Martinsburg Shale
Pennsylvania
Porosity (total) (units not stated)
ranges from: 0.010
to: -
Source: ORNL-6241/V2 (in preparation)
p. 52

Muddy Shale
Colorado
Porosity (%)
ranges from: 4.1
to: 5.1
Source: Y/OWI/SUB-7009/1 (1976), p. 14

New Albany Shale
Illinois, Indiana and Kentucky
Density (bulk) (average) (g/cm(3))
ranges from: 2.36
to: 2.53
Source: ORNL-5703 (1983), p. 76

New Albany Shale
Illinois, Indiana, Kentucky
Porosity (%)
ranges from: 0.95
to: 4.64
Source: ORNL/Sub/84-64794/1 (1985),
p. 85

New Albany Shale
Illinois, Indiana and Kentucky
Porosity (average) (vol. %)
ranges from: 0.95
to: 4.64
Source: ORNL-5703 (1983), p. 76

New Albany Shale
Illinois, Indiana, Kentucky
Porosity (total) (units not stated)
ranges from: 0.009
to: 0.046
Source: ORNL-6241/V2 (in preparation)
p. 52

Olentangy and Huron Shale
Ohio
Porosity (primary) (%)
ranges from: >3 %
to: -
Source: ORNL/Sub/84-64794/1 (1985),
p. 108

Olentangy and Huron Shales
Ohio
Density (bulk) (g/cm(3))
ranges from: 2.65
to: -
Source: ORNL/Sub/84-64794/1 (1985),
p. 108

Ophir Shale
 Utah
Porosity (total) (units not stated)
 ranges from: 0.009
 to: -
 Source: ORNL-6241/V2 (in preparation)
 p. 52

Oxford Clay
 England
Density (bulk) (kg/m(3))
 ranges from: 2210 (2.210 g/cm(3))
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle, v. 6 (1985), p. 54

Oxford Clay
 England
Porosity (%)
 ranges from: 30
 to: -
 Source: Rad Waste Management and Nuclear
 Fuel Cycle, v. 6 (1985), p. 54

Panther Creek Clay
Density (g/cm(3))
 ranges from: <1.7
 to: ca. 2.14
 Source: PNL-4452 UC-70 (1983), p. 24

Pierre Shale
 Northern Great Plains
Density (dry) (lb/cu ft)
 ranges from: 95 (1.522 g/cm(3))
 to: 110 (1.762 g/cm(3))
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
 Western USA
Moisture content (%)
 ranges from: 35
 to: 15
 Source: Y/OWI/TM36/6, p. 3-1

Pierre Shale
Moisture content (natural) (%)
 ranges from: 18
 to: -
 Source: Y/OWI/TM36/6, p. 3-24

Pierre Shale
 Northern Great Plains
Moisture content (natural) (%)
 ranges from: 18
 to: 38
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Porosity (%)
 ranges from: 33
 to: -
 Source: Y/OWI/TM36/6, p. 3-24

Pierre, Bearpaw and Claggett Shales
Moisture content (natural) (%)
 ranges from: 38
 to: 12
 Source: Y/OWI/SUB-7009/1 (1976), p. 14

Porter's Creek Clay
 Louisiana
Density (kg/m(3))
 ranges from: 1,954 (1.954 g/cm(3))
 to: -
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 173

Antrim Shale
Michigan
Permeability (md)
ranges from: 0.001 ($1 \times 10(-9)$ cm/s)
to: 2.0 ($1.9 \times 10(-6)$ cm/s)
Source: ORNL/5703 (1983), p. 109

Antrim Shale
Michigan
Permeability (md)
ranges from: 0.001 ($1 \times 10(-9)$ cm/s)
to: 2.0 ($1.9 \times 10(-6)$ cm/s)
Source: ORNL/Sub/84-64794/1 (1985),
p. 98

Arnheim and Waynesville Fms
Ohio
Permeability (ft/yr) (hydraulic conductivity)
ranges from: $10(-3)$ ($9.7 \times 10(-10)$ cm/s)
to: $10(-4)$ ($9.7 \times 10(-11)$ cm/s)
Source: Y/OWI/TM36/6 (1978), p. 5-14

Blue Clay
Italy
Hydraulic conductivity (m/s)
ranges from: $10(-11)$ ($1 \times 10(-9)$ cm/s)
to:
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Boom Clay
Belgium
Hydraulic conductivity (m/s)
ranges from: $10(-10)$ ($1 \times 10(-8)$ cm/s)
to: $10(-12)$ ($1 \times 10(-10)$ cm/s)
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Chagrin Shale
Ohio
Permeability (horizontal) (ft/yr) (hydraulic conductivity)
ranges from: 0.1 ($9.7 \times 10(-8)$ cm/s)
to:
Source: Y/OWI/TM36/6 (1978), p. 4-12

Chagrin Shale
Ohio
Permeability (vertical) (ft/yr) (hydraulic conductivity)
ranges from: 0.05 ($5 \times 10(-8)$ cm/s)
to:
Source: Y/OWI/TM36/6 (1978), p. 4-12

Conasauga Shale
Tennessee
Hydraulic conductivity (cm/s)
ranges from: $6 \times 10(-10)$
to: $3 \times 10(-11)$
Source: ORNL-6241/V2 (in preparation)
p. 220

Conasauga Shale
Tennessee
Hydraulic conductivity (horizontal) (m/s)
ranges from: $3 \times 10(-13)$ ($3 \times 10(-11)$ cm/s)
to: $2 \times 10(-12)$ ($2 \times 10(-10)$ cm/s)
Source: ORNL-6241/V2 (in preparation)
p. 42

Maquoketa Shale
Illinois Basin
Hydraulic conductivity (cm/s)
ranges from: $10(-9)$
to:
Source: ORNL-6241/V2 (in preparation)
p. 220

Maquoketa Shale
Illinois
Hydraulic conductivity (horizontal) (m/s)
ranges from: $2 \times 10(-11)$ ($2 \times 10(-9)$ cm/s)
to:
Source: ORNL-6241/V2 (in preparation)
p. 42

Muddy Shale
Permeability (md)
ranges from: $5 \times 10(-2)$ ($4.9 \times 10(-7)$ cm/s)
to:
Source: Y/OWI/SUB-7009/1 (1976), p. 11

Muddy Shale
Colorado
Permeability (md)
ranges from: <0.05 ($<4.9 \times 10(-7)$ cm/s)
to:
Source: Y/OWI/SUB-7009/1 (1976), p. 14

Oxford Clay
England
Hydraulic conductivity (m/s)
ranges from: $10(-12)$ ($1 \times 10(-10)$ cm/s)
to:
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Panther Creek Clay
Hydraulic conductivity (cm/s)
ranges from: $7 \times 10(-12)$
to: $2 \times 10(-12)$
Source: PNL-4452 UC-70 (1983), p. 14

Pierre Shale
South Dakota
Hydraulic conductivity (horizontal) (m/s)
ranges from: $1 \times 10(-12)$ ($1 \times 10(-10)$ cm/s)
to: $1 \times 10(-11)$ ($1 \times 10(-9)$ cm/s)
Source: ORNL-6241/V2 (in preparation)
p. 43

Pierre Shale
Great Plains
Permeability (cm/s) (hydraulic conductivity)
ranges from: $1 \times 10(-6)$
to: $1 \times 10(-10)$
Source: ORNL/Sub/84-64794/1 (1985),
p. 293

Pierre Shale
Permeability (horizontal) (ft/yr) (hydraulic conductivity)
ranges from: 0.01 ($9.7 \times 10(-9)$ cm/s)
to:
Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Permeability (md)
ranges from: $1.1 \times 10(-4)$ ($1.1 \times 10(-10)$ cm/s)
to:
Source: Y/OWI/SUB-7009/1 (1976), p. 11

Pierre Shale
Permeability (vertical) (ft/yr) (hydraulic conductivity)
ranges from: 0.005 ($5 \times 10(-9)$ cm/s)
to:
Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre, Bearpaw and Claggett Shales
Northern Great Plains
Hydraulic conductivity (cm/s)
ranges from: $10(-6)$
to: $10(-10)$
Source: ORNL-6241/V2 (in preparation)
p. 220

Porters Creek Clay
Louisiana
Hydraulic conductivity (cm/s)
ranges from: $10(-8)$ (est)
to:
Source: ORNL/Sub/84-64794/1 (1985),
p. 175

Arnhelm and Waynesville Fms

Ohio

Bulk modulus (psi)
 ranges from: $6.3 \times 10(5)$ ($4.3 \times 10(3)$ MPa)
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Arnhelm and Waynesville Fms

Ohio

Cohesion (psi)
 ranges from: 5,900 ($4.1 \times 10(1)$ MPa)
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Arnhelm and Waynesville Fms

Ohio

Compressive strength (uniaxial) (psi)
 ranges from: $1 \times 10(4)$ ($6.9 \times 10(1)$ MPa)
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Arnhelm and Waynesville Fms

Ohio

Friction angle (deg)
 ranges from: 23.4
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Arnhelm and Waynesville Fms

Ohio

Poisson's ratio
 ranges from: 0.1
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Arnhelm and Waynesville Fms

Ohio

Shear modulus (psi)
 ranges from: $6.8 \times 10(5)$ ($4.7 \times 10(3)$ MPa)
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Arnhelm and Waynesville Fms

Ohio

Tensile strength (psi)
 ranges from: 200 (1.4 MPa)
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Arnhelm and Waynesville Fms

Ohio

Young's modulus (psi)
 ranges from: $1.5 \times 10(6)$ ($1 \times 10(4)$ MPa)
 to: -

Source: Y/OWI/TM36/6 (1978), p. 5-14

Bearpaw Shale

Montana

Compressive strength (kg/cm²)
 ranges from: 122 ($1.2 \times 10(1)$ MPa)
 to: 25 (2.5 MPa)

Source: Y/OWI/TM36/6 (1978), p. 6-13

Bearpaw Shale

Montana

Compressive strength (kg/cm²)
 ranges from: 25 (2.5 MPa)
 to: 55 (5.4 MPa)

Source: Y/OWI/TM36/6 (1978), p. 6-13

Bearpaw Shale

Montana

Plasticity (liquidity index)
 ranges from: -0.11
 to: -

Source: Y/OWI/TM36/6 (1978), p. 6-1

Blue Clay

Italy

Cohesion (MPa)
 ranges from: $1 \times 10(-1)$
 to: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Blue Clay

Italy

Friction angle (angle of shear resistance) (deg)
 ranges from: 25
 to: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Blue Clay

Italy

Plasticity (liquid limit) (%)
 ranges from: 50
 to: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Blue Clay

Italy

Plasticity (plastic limit) (%)
 ranges from: 25
 to: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Blue Clay

Italy

Shear strength (undrained) (MPa)
 ranges from: 1.5
 to: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Blue Clay

Italy

Young's modulus (elastic modulus) (MPa)
 ranges from: 300
 to: -

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Boom Clay

Belgium

Cohesion (MPa)
 ranges from: $1 \times 10(-1)$
 to: 1

Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Boom Clay Belgium	Chagrin Shale Ohio
Friction angle (angle of shear resistance) (deg)	Compressive strength (uniaxial) (psi) ranges from: $2 \times 10(3)$ ($1.4 \times 10(1)$ MPa)
ranges from: 19 to: -	to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	Source: Y/OWI/TM36/6 (1978), p. 4-12
Boom Clay Belgium	Chagrin Shale Ohio
Plasticity (liquid limit) (%)	Friction angle (deg)
ranges from: 77.5 to: -	ranges from: 22 to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	Source: Y/OWI/TM36/6 (1978), p. 4-12
Boom Clay Belgium	Chagrin Shale Ohio
Plasticity (plastic limit) (%)	Poisson's ratio
ranges from: 26.5 to: -	ranges from: 0.25 to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	Source: Y/OWI/TM36/6 (1978), p. 4-12
Boom Clay Belgium	Chagrin Shale Ohio
Shear strength (undrained) (MPa)	Shear modulus (psi)
ranges from: 0.6 to: -	ranges from: $6.8 \times 10(4)$ ($4.7 \times 10(2)$ MPa)
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	to: -
Source: Y/OWI/TM36/6 (1978), p. 4-12	Source: Y/OWI/TM36/6 (1978), p. 4-12
Boom Clay Belgium	Chagrin Shale Ohio
Young's modulus (elastic modulus) (MPa)	Tensile strength (MPa)
ranges from: 170 to: -	ranges from: 0.34 to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54	Source: ORNL/Sub/84-64794/1 (1985), p. 108
Chagrin Shale Ohio	Chagrin Shale Ohio
Bulk modulus (psi)	Tensile strength (psi)
ranges from: $1.1 \times 10(5)$ ($7.6 \times 10(2)$ MPa)	ranges from: 50 ($3.4 \times 10(-1)$ MPa)
to: -	to: -
Source: Y/OWI/TM36/6 (1978), p. 4-12	Source: Y/OWI/TM36/6 (1978), p. 4-12
Chagrin Shale Ohio	Chagrin Shale Ohio
Cohesion (psi)	Young's modulus (psi)
ranges from: 14 ($1 \times 10(-1)$ MPa)	ranges from: $1.7 \times 10(5)$ ($1.2 \times 10(3)$ MPa)
to: -	to: -
Source: Y/OWI/TM36/6 (1978), p. 4-12	Source: Y/OWI/TM36/6 (1978), p. 4-12
Chagrin Shale Ohio	Eleana Argillite Bulk modulus (confined) (GPa)
Compressive strength (uniaxial) (MPa)	ranges from: 14.0 ($1.4 \times 10(4)$ MPa)
ranges from: 13.8 to: -	to: -
Source: ORNL/Sub/84-64794/1 (1985), p. 108	Source: Proc NEA Workshop OECD (1979b), p. 87
Chagrin Shale Ohio	Eleana Argillite Cohesion (unconfined) (MPa)
Compressive strength (uniaxial) (MPa)	ranges from: $8 \times 10(-1)$
ranges from: 13.8 to: -	to: -
Source: ORNL/Sub/84-64794/1 (1985), p. 108	Source: Proc NEA Workshop OECD (1979b), p. 87

Eleana Argillite
Compressive strength (unconfined) (MPa)
 ranges from: 4.75
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 87

Eleana Argillite
Friction angle (internal) (deg)
 ranges from: 35
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 87

Eleana Argillite
Poisson's ratio
 ranges from: 0.30
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 87

Eleana Argillite
Tensile strength (MPa)
 ranges from: 3.5
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 81

Eleana Argillite
Young's modulus (GPa)
 ranges from: 3.7 (3.7 x 10(3) MPa)
 to: 16 (MPa)
 Source: Proc NEA Workshop OECD (1979b),
 p. 83

Eleana Argillite
Young's modulus (unconfined) (GPa)
 ranges from: 3.74 (3.7 x 10(3) MPa)
 to: -
 Source: Proc NEA Workshop OECD (1979b),
 p. 87

Hucknall Shale
Compressive strength (psi)
 ranges from: 8.5 x 10(3) (5.9 x 10(1) MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 6-3

Hucknall Shale
Young's modulus (elastic modulus) (psi x 10(6))
 ranges from: 1.48 (1 x 10(4) MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 6-3

Lewis Shale
New Mexico
Compressive strength (psi)
 ranges from: 1,000 (6.9 MPa)
 to: 6,000 (4.1 x 10(1) MPa)
 Source: Y/OWI/TM36/6 (1978), p. 8-5

Mancos Fm
New Mexico
Compressive strength (psi)
 ranges from: 1,000 (6.9 MPa)
 to: 8,000 (5.5 x 10(1) MPa)
 Source: Y/OWI/TM36/6 (1978), p. 8-2

Maquoketa Group
Indiana
Compressive strength (MPa)
 ranges from: 11
 to: 115
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 60

Oxford Clay
England
Plasticity (liquid limit) (%)
 ranges from: 55
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Oxford Clay
England
Plasticity (plastic limit) (%)
 ranges from: 26
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Oxford Clay
England
Shear strength (undrained) (MPa)
 ranges from: 1.2
 to: -
 Source: Rad Waste Management and Nuclear Fuel Cycle v.6 (1985), p. 54

Pierre Shale
Bulk modulus (psi)
 ranges from: 77.8 x 10(3) (5.4 x 10(2) MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Cohesion (psi)
 ranges from: 206 (1.4 MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Great Plains
Cohesion (psi)
 ranges from: 2 (1.4 x 10(-2) MPa)
 to: 30 (2.1 x 10(-1) MPa)
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Great Plains
Compressive strength (psi)
 ranges from: 70 (4.8 x 10(-1) MPa)
 to: 2,530 (1.7 x 10(1) MPa)
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Compressive strength (uniaxial) (psi)
 ranges from: 2.1 x 10(3) (1.4 x 10(1) MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Friction angle (deg)
 ranges from: 5.3
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Great Plains
Friction angle (internal) (deg)
 ranges from: 8
 to: 25
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Great Plains
Plasticity (liquid limit) (%)
 ranges from: 36
 to: 113
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 291

Pierre Shale
Great Plains
Plasticity (liquid limit) (%)
 ranges from: 55
 to: 202
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Great Plains
Plasticity (plastic limit) (%)
 ranges from: 20
 to: 62
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 291

Pierre Shale
Great Plains
Plasticity (plastic limit) (%)
 ranges from: 22
 to: 39
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Great Plains
Plasticity (plasticity index) (%)
 ranges from: 30
 to: 110
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Poisson's ratio
 ranges from: 0.2
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Shear modulus (psi)
 ranges from: $58.3 \times 10(3)$ ($4 \times 10(2)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Great Plains
Swelling (potential) (%)
 ranges from: 3
 to: 5
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Tensile strength (psi)
 ranges from: 50 ($3.4 \times 10(-1)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale
Great Plains
Young's modulus (elastic modulus) (psi x 10(6))
 ranges from: 0.02 ($1.4 \times 10(2)$ MPa)
 to: 0.014 ($9.6 \times 10(1)$ MPa)
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Pierre Shale
Young's modulus (psi)
 ranges from: $1.4 \times 10(5)$ ($9.7 \times 10(2)$ MPa)
 to: -
 Source: Y/OWI/TM36/6 (1978), p. 3-24

Pierre Shale (equivalent)
Canada
Swelling (potential) (%)
 ranges from: 2
 to: 20
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 293

Porters Creek Clay
Louisiana
Plasticity (plasticity index) (%)
 ranges from: 40
 to: -
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 173

Porters Creek Clay
Louisiana
Strength (MPa)
 ranges from: 0.19
 to: -
 Source: ORNL/Sub/84-64794/1 (1985),
 p. 173

Blue Clay
Italy
Specific heat (J/Kg-K) (specific heat capacity)
ranges from: $9.21 \times 10(2)$
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Blue Clay
Italy
Thermal conductivity (W/m-K)
ranges from: 1.5
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Blue Clay
Italy
Thermal diffusivity (m²/s)
ranges from: $7.8 \times 10(-7)$
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Boom Clay
Belgium
Specific heat (J/Kg-K) (specific heat capacity)
ranges from: $9.21 \times 10(2)$
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Boom Clay
Belgium
Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
ranges from: ca. 0.3
to: -
Source: Proc NEA Workshop OECD (1979b), p. 87

Boom Clay
Belgium
Thermal conductivity (W/m-K)
ranges from: 1.5
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Boom Clay
Belgium
Thermal diffusivity (m²/s)
ranges from: $18.6 \times 10(-7)$
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Conasauga Shale
Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
ranges from: 0.715
to: 2.20
Source: ORNL-6241/V3 (In preparation) p. 340

Eleana
Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
ranges from: ca. 1.80
to: -
Source: Proc NEA Workshop OECD (1979b), p. 87

Eleana
Thermal conductivity (matrix) (W/m-deg C) (W/m-K)
ranges from: ca. 1.48
to: -
Source: Proc NEA Workshop OECD (1979b), p. 87

Eleana Argillite
Coefficient of linear expansion (deg C(-1)) (K(-1))
ranges from: $8 \times 10(-6)$
to: $15 \times 10(-6)$
Source: Proc NEA Workshop OECD (1979b), p. 77

Eleana Argillite
Nevada
Thermal conductivity (W/m-K)
ranges from: 1.28
to: 2.7
Source: ORNL-6241/V3 (In preparation) p. 341, 342

Karoo Shale
Orange Free State
Thermal conductivity (W/m-K)
ranges from: 1.97
to: 2.89
Source: ORNL-6241/V3 (In preparation) p. 341

Nonesuch Shale
Michigan
Thermal conductivity (W/m-K)
ranges from: 2.64
to: -
Source: ORNL-6241/V3 (In preparation) p. 341

Oxford Clay
England
Thermal conductivity (W/m-K)
ranges from: 1.56
to: -
Source: Rad Waste Management and Nuclear Fuel Cycle v. 6 (1985), p. 54

Pierre Shale
Thermal conductivity (W/m-K)
ranges from: 1.42
to: 1.94
Source: ORNL-6241/V3 (In preparation) p. 341

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