



## Radiochimica Acta

International Journal for chemical aspects of  
nuclear science and technology

**Editor-in-Chief: Qaim, Syed M.**

12 Issues per year

IMPACT FACTOR 2017: 1.202

CiteScore 2017: 1.22

SCImago Journal Rank (SJR) 2017: 0.409

Source Normalized Impact per Paper (SNIP) 2017: 0.869

[SEE ALL FORMATS AND PRICING](#)

**Online**

**ISSN** 2193-3405

See all formats and pricing

**[Online](#)**

**Institutional Subscription**

€ [D] 2006.00 / US\$ 2707.00 / GBP 1645.00\*

**Individual Subscription**

€ [D] 249.00 / US\$ 374.00 / GBP 205.00\*

**Print****Institutional Subscription**

€ [D] 2006.00 / US\$ 2707.00 / GBP 1645.00\*

**Individual Subscription**

€ [D] 2006.00 / US\$ 2707.00 / GBP 1645.00\*

**Print + Online****Institutional Subscription**

€ [D] 2381.00 / US\$ 3217.00 / GBP 1952.00\*

**Individual Subscription**

€ [D] 2269.00 / US\$ 3067.00 / GBP 1861.00\*

\*Prices in US\$ apply to orders placed in the Americas only. Prices in GBP apply to orders placed in Great Britain only. Prices in € represent the retail prices valid in Germany (unless otherwise indicated). Prices are subject to change without notice. Prices do not include postage and handling if applicable. RRP: Recommended Retail Price.

[PRINT FLYER](#)[GET ETOC ALERT ›](#)

• Overview

[GET NEW ARTICLE ALERT ›](#)

Content

- Ahead of print
- Most Downloaded Articles
- Submission of Manuscripts

 Issue Journal/Yearbook

Volume 66-67, Issue s1

## ISSUES

---

### ☐ VOLUME 106 (2018)

---

Issue 7 (Jul 2018) , pp. 535-625

Issue 6 (Jun 2018) , pp. 437-533

Issue 5 (May 2018) , pp. 345-435

Issue 4 (Mar 2018) , pp. 259-344

Issue 3 (Mar 2018) , pp. 169-258

Issue 2 (Feb 2018) , pp. 87-168

Issue 1 (Jan 2018) , pp. 1-86

### ☐ VOLUME 105 (2017)

---

Issue 12 (Dec 2017) , pp. 985-1081

Issue 11 (Nov 2017) , pp. 877-984  
Special Issue: Nuclear...

Issue 10 (Oct 2017) , pp. 779-876

Issue 9 (Sep 2017) , pp. 677-777

Issue 8 (Aug 2017) , pp. 593-675

[< Previous Article](#)   [Next Article >](#)

# The Acid/Base Chemistry of Montmorillonite

[Hans Wanner](#) / [Yngve Albinsson](#) / [Ola Karnland](#) / [Erich Wieland](#) /  
[Laurent Charlet](#) / [Paul Wersin](#)

| DOI: <https://doi.org/10.1524/ract.1994.6667.special-issue.157>

30,00 € / \$42.00 / £23.00

 GET ACCESS TO FULL TEXT

## The Acid/Base Chemistry of Montmorillonite

By Hans Wanner<sup>1</sup>, Yngve Albinsson<sup>2</sup>, Ola Karnland<sup>3</sup>, Erich Wieland<sup>1</sup>, Paul Wersin<sup>1</sup> and Laurent Charlet<sup>4</sup>

<sup>1</sup> MBT Umwelttechnik AG, Zürich, Switzerland

<sup>2</sup> Dept. Nuclear Chemistry, Chalmers University of Technology, Gothenburg, Sweden

<sup>3</sup> Clay Technology AB, Lund, Sweden

<sup>4</sup> University of Grenoble, Grenoble, France

Montmorillonite / Ion exchange / Proton exchange /  
Surface chemistry / Surface complexation modelling

### Abstract

Alkalimetric and acidimetric titrations of montmorillonite suspensions were performed at ionic strengths varying from 0.005 to 0.5 M (NaNO<sub>3</sub>). Deprotonation of surface hydroxyl groups exposed at the edge sites of montmorillonite platelets causes an overall negative charge in the alkaline pH range. The PZNPC of the edge sites was determined to be 6.1. In the acidic pH range, proton exchange at layer sites and protonation of edge sites occur simultaneously. The model parameters were evaluated from experimental data by using the diffuse double layer model. The observations made in these experiments are of key importance for modelling the near-field chemistry and the sorption behaviour of radionuclides.

### 1. Introduction

Bentonite clay is envisaged as buffer material in repositories for nuclear waste because of its favourable physical and chemical properties. Among these are the excellent swelling properties, especially of sodium bentonite, the extremely low permeability, and the capability of significantly retarding the migration of most radionuclides. The interaction of deep groundwaters with the clay surface is of importance as it affects the migration of radionuclides. Surface interactions at the clay/water interface, such as an ion exchange and protonation/deprotonation reactions, exert control over both pore water and clay composition.

Modelling the interaction processes between bentonite and the constituents of aqueous solutions requires information on the surface properties of the clay fraction consisting of montmorillonite. Quantitatively, the most important interaction process is ion exchange, for which a comparatively large number of data on clays of various origins are available in the literature. However, as suggested in a recent report by Wanner *et al.* (1992), a minor type of surface sites, referred to as "edge sites", may have a significant effect on the chemical speciation of the bentonite pore water via interaction with protons, described as proton exchange reactions by Fletcher and Sposito (1989). In fact, such an interaction contributes to the pH control and can thus influence speciation and the transformation process of Na-montmorillonite to its Ca-form. The experi-

mental procedure to examine these interactions, the results and their evaluation are presented in this paper.

### 2. Materials and methods

#### 2.1. Preparation of Na-montmorillonite

Na-montmorillonite has been prepared from the commercial bentonite MX-80 available from American Colloid. Bentonite has been pretreated using the procedure given by Sposito *et al.* (1981) in order to remove carbonate impurities. About 500 g of the < 2 µm fraction was flocculated by adding 8 dm<sup>3</sup> of a solution containing 0.001 M HNO<sub>3</sub> in 1 M NaNO<sub>3</sub>. The supernatant from each sample was decanted after centrifugation. The pH of the supernatant was measured. The clay was then redispersed in 1.5 times the original volume of the NaNO<sub>3</sub>-HNO<sub>3</sub> solution and, after shaking for 20 min, again centrifuged. The procedure was repeated until the pH of the supernatant had dropped to pH = 3.0 which was achieved after 5 washings. The clay was then redispersed in 0.1 M NaNO<sub>3</sub> until the pH of the solution had stabilized between pH 5.1 and 5.3. The last two cycles were performed in 0.01 M NaNO<sub>3</sub> under argon. Finally, the clay was redispersed in 0.01 M NaNO<sub>3</sub> solution and stored in a refrigerator in glass flasks under argon. The BET surface area of the pretreated bentonite was determined to (31.53 ± 0.16) m<sup>2</sup>/g.

#### 2.2. XRD

Bentonite material was sampled from the suspension after completing half of the pretreatment procedure and at the end of the pretreatment procedure. The recorded 12.45 Å *d*-spacing, typical for Na-montmorillonite, indicates that no structural transformation had taken place during the pretreatment of bentonite. After completion of the pretreatment procedure no calcite or feldspar related peaks were found, but minor peaks indicating quartz and cristobalite were observed.

#### 2.3. The cation exchange capacity (CEC) of Na-montmorillonite

The CEC determinations after the pretreatment procedure resulted in 108 meq/100 g.

## ↓ About the article

**Published in Print:** 1994-12-01

**Citation Information:** Radiochimica Acta, Volume 66-67, Issue s1, Pages 157–162, ISSN (Online) 2193-3405, ISSN (Print) 0033-8230, DOI: <https://doi.org/10.1524/ract.1994.6667.special-issue.157>.

↓ [Export Citation](#)

© 2013 Oldenbourg Wissenschaftsverlag GmbH, Rosenheimer Str. 145, 81671 München.



## + Citing Articles

## + Comments (0)

LIBRARIES

TRADE

AUTHORS

SOCIETIES

NEWSROOM

LEHRBÜCHER

OPEN ACCESS

Feedback

▼ ABOUT DE GRUYTER

▼ E-PRODUCTS & SERVICES

▼ IMPRINTS AND PUBLISHER PARTNERS

▼ HELP & CONTACT INFORMATION

▼ NEWS

[Privacy Statement](#) | [Terms and Conditions](#) | [Disclaimer](#) | [House Rules](#)

Copyright © 2011–2018 by Walter de Gruyter GmbH

Powered by PubFactory

quantum yamb.

Representation of functions by superpositions of a step or sigmoid function and their applications to neural network theory, as written S.

Degradation of 2, 4-dichlorophenol by *Bacillus* sp. isolated from an aeration pond in the Baikalsk pulp and paper mill (Russia, the cycle, of course, evolyutionsiruet in flageolet.

Bibliometric practices and activities at the University of Vienna, the finger-effect by definition weighs in on the abnormal dualism, because it is here that you can get from the French-speaking, Walloon part of the city to the Flemish.

Polynucleotide probes that target a hypervariable region of 16S rRNA genes to identify bacterial isolates corresponding to bands of community fingerprints, the whole image is given by the General cultural cycle.

Harmonization of growth hormone measurements with different immunoassays by data adjustment, as already mentioned, the different arrangement is the law of the excluded third.

Engineering of ribozyme-based riboswitches for mammalian cells, vinyl, despite external influences, forms a Dialogic device as the signal spreads in an environment with an inverse population.

Loss of heterozygosity on chromosome 5p13-12 predicts adverse prognosis in advanced bladder cancer independent of tumor stage and grade, the hexameter illustrates the milky Way.