

## Preface on physicochemical and electromechanical interactions in porous media

**Citation for published version (APA):**

Huyghe, J. M. R. J., & Cowin, S. C. (2003). Preface on physicochemical and electromechanical interactions in porous media. *Transport in Porous Media*, 50(1-2), 1-3. <https://doi.org/10.1023/A:1020682004427>

**DOI:**

[10.1023/A:1020682004427](https://doi.org/10.1023/A:1020682004427)

**Document status and date:**

Published: 01/01/2003

**Document Version:**

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

**Please check the document version of this publication:**

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

**General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

[www.tue.nl/taverne](http://www.tue.nl/taverne)

**Take down policy**

If you believe that this document breaches copyright please contact us at:

[openaccess@tue.nl](mailto:openaccess@tue.nl)

providing details and we will investigate your claim.



## Preface on Physicochemical and Electromechanical Interactions in Porous Media

JACQUES M. HUYGHE<sup>1</sup> and STEPHEN C. COWIN<sup>2</sup>

<sup>1</sup>*Department of Biomedical Engineering, Eindhoven University of Technology, Eindhoven, The Netherlands*

<sup>2</sup>*Department of Biomedical and Mechanical Engineering, City University of New York, New York, NY, U.S.A.*

(Accepted: 1 September 2002)

**Abstract.** The focus of science and engineering shifts towards smaller length scales. Porous media mechanics has a vital role to play in the translation of microstructural data into macroscopic models of multicomponent systems. As the length scales shrink, more fundamental levels of understanding of natural laws, cause the boundaries between disciplines to blur. In particular, geosciences, polymer sciences and biosciences find a common ground of interest in high specific surface mixtures.

**Key words:** living cells, biomechanics, geomechanics, high specific surface.

The focus of technological development is shifting towards smaller length scales. The development of advanced experimental techniques allows us to fathom more subtle levels of the material than ever before. The advent of cheap and high computational power opens the way to translate measured material properties on the molecular level towards workable macroscopic models which are useful for technological applications in industry and medical practice. A spin-off of these developments is that as one moves towards the molecular level, the boundaries between the different disciplines of engineering fade away. Multi-physics problems are the rule rather than the exception on that level. Engineers and scientists are bumping into major problems of communication between entirely different disciplines, calling for a rethinking of the educational curricula. Porous media mechanics and mixture theory have a major role to play in the translation of the nano to the micro and the macro level of the material. The purpose of this special issue is to bring together a number of high quality papers that deal with the interface between mechanics of porous media and other sciences. In the choice of subjects, we deliberately distributed our attention between geomechanical and biomedical applications. The high adsorption forces in the low porosity stratum corneum of the human skin which are shown so important for the water management of our own body (van Kemenade *et al.*, 2003), is closely related to the adsorption forces measured in the low porosity, high specific surface rocks like shales which are main building

block of the earth crust (Moyné and Murad, 2003; van Meerveld *et al.*, 2003). The Donnan osmotic pressure in cartilage discussed in detail by Athesian *et al.* (2003), is a macroscopic form of the double layer theory used by Dormieux *et al.* (2003) in the context of clays. DiMicco and Sah (2003) discuss cartilage as a porous medium including metabolic events. Cowin (2003) presents a matrix formulation of anisotropic poroelasticity, that refers repeatedly to work of previous authors in the field of rock mechanics, while his own work concentrates on the poromechanics of bone and its relationship to the stress sensing ability of bone. While the understanding of coupling between electrostatics and poromechanics starts to converge towards established theories, the coupling between electrodynamics and wave propagation in porous media is still difficult to unravel. Santamarina and Fratta (2003) are presenting some experimental data, and interpret their results in the light of present understanding of electrical–mechanical coupling. Recent developments in the field of cell biomechanics (Tasaki, 1999), seem to indicate that subcellular events, which are essential building blocks of life, may also call for porous media description, as direct interaction between intracellular ions, intracellular water and the cytoskeleton are in some ways comparable to interactions of ions, water and polymeric chains in hydrogels (Pollack, 2001). In order to give further impetus to the rising interest in porous mechanics of high specific surface and molecular mixtures, the guest editors of this special issue have decided to organise a IUTAM-symposium on 18–23 May 2003, in Kerkrade, The Netherlands on the subject of “Mechanics of physicochemical and electromechanical interactions in porous media”.

## References

- Athesian, G. A., Soltz, M. A., Mauck, R. L., Hung, C. T. and Lai, W. M.: 2003, ‘The role of osmotic pressure in the frictional response of articular cartilage’. *Transport in porous media* **50**, 5–33.
- Cowin, S. C.: 2003, ‘A recasting of anisotropic poroelasticity in matrices of tensor components’. *Transport in porous media* **50**, 35–56.
- Dimicco, M. A. and Sah, R. L.: 2003, ‘Dependence of cartilage matrix composition on biosynthesis, diffusion and reaction’. *Transport in porous media* **50**, 57–73.
- Dormieux, L., Lemarchand, E. and Coussy, O.: 2003, ‘Macroscopic and micromechanical approaches to the modelling of the osmotic swelling in clays’. *Transport in porous media* **50**, 75–91.
- Moyné, C. and Murad, M.: 2003, ‘Macroscopic behaviour of swelling porous media derived from micromechanical analysis’. *Transport in porous media* **50**, 127–151.
- Pollack, G. H.: 2001, *Cells, Gels and the Engines of Life; a New Unifying Approach to Cell Function*. Seattle, WA, USA: Ebner and Sons.
- Santamarina, J. C. and Fratta, D. O.: 2003, ‘Dynamic electrical–mechanical energy coupling in electrolyte–mineral systems – Low frequency range’. *Transport in porous media* **50**, 153–178.
- Tasaki, I.: 1999, ‘Evidence for phase transition in nerve fibers, cells and synapses’. *Ferroelectrics* **220**, 205–316.

- van Kemenade, P. M., Huyghe, J. M. and Douven, L. F. A.: 2003, 'Triphasic FE modeling of the skin water barrier'. *Transport in porous media* **50**, 93–109.
- van Meerveld, J., Molenaar, M. M., Huyghe, J. M. and Baaijens, F. P. T.: 2003, 'Analytical solution of compression, free swelling and electrical loading of saturated charged porous media'. *Transport in porous media* **50**, 111–126.