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Theoretical Analysis of Transport in Porous Media

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1. INTRODUCTION

In this study of transport in porous media, we consider the system illustrated in Figure 1 where the σ-phase represents a rigid, impermeable solid phase and the β-phase represents a Newtonian fluid. The nomenclature used in this presentation differs from that employed in other chapters in this volume where the *solid phase* is denoted by a subscript s and the *fluid phase* by a subscript f. Petroleum engineers prefer to designate fluids using either w or n depending on whether they are *wetting* or *non-wetting*, and chemical engineers favor g or ℓ depending on whether the fluid is a *gas* or a *liquid*. In our case, we prefer a *discipline-free* nomenclature in which Greek subscripts are used to identify *distinct regions in space*. In this chapter, we are concerned with only two distinct regions in space and we refer to them as the σ-phase and the β-phase, as indicated in Figure 1. This type of nomenclature carries over quite conveniently to hierarchical porous media (Cushman, 1990, 1997) where one must identify *various regions* in addition to the *several phases* that exist in those regions. One often thinks of hierarchical porous media as geological in origin and therefore a special case; however, the typical packed bed catalytic reactor (Whitaker, 1989) is hierarchical in nature and transport processes must be examined in both *phases* and *regions*.

In this treatment of heat transfer in porous media, *coupling* between the transport processes under consideration will be ignored. There are many

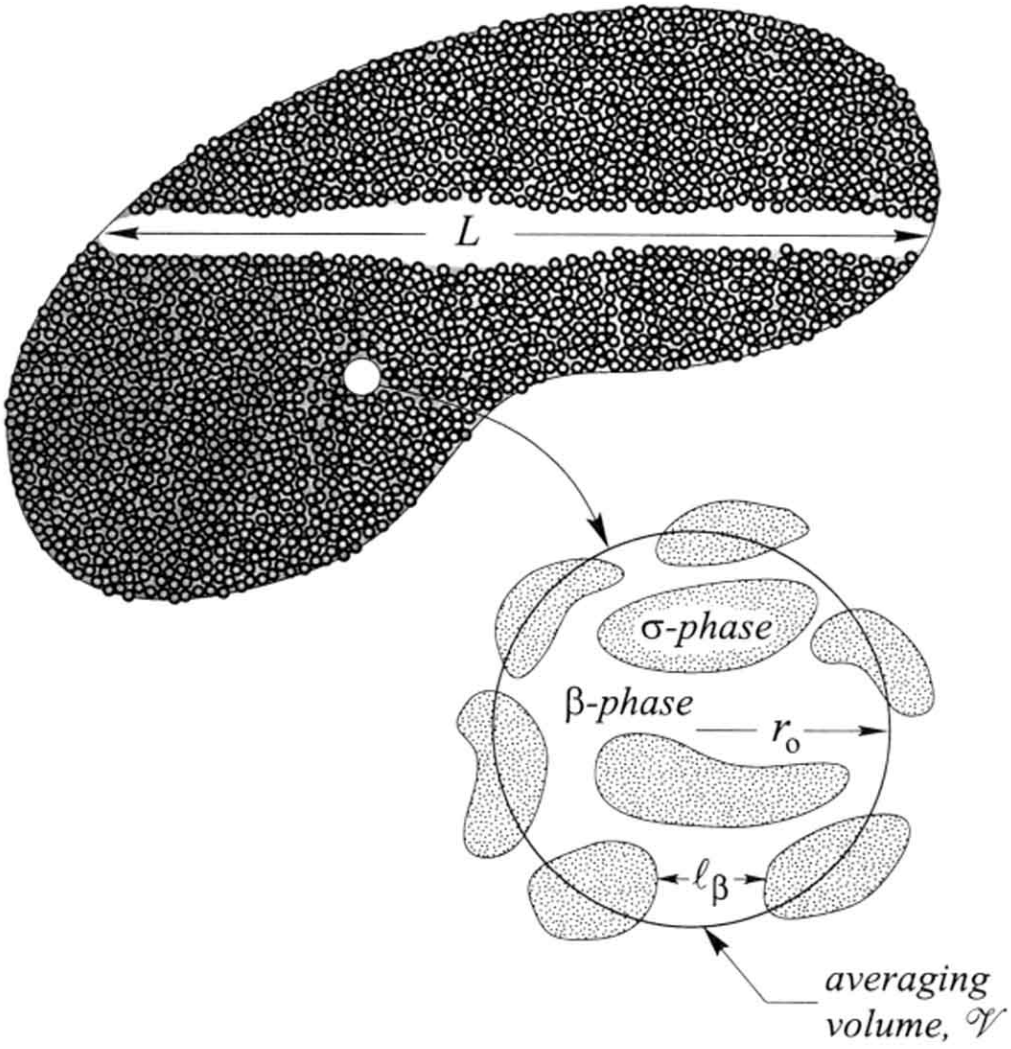

Figure 2. Macroscopic region and averaging volume.