7. GEOMECHANICAL INVESTIGATIONS

7.1 Introduction

7.1.1 Pressure management

Geomechanics is concerned with understanding the mechanical response of rock and soil under various conditions. In terms of the storage of carbon dioxide, the bulk of the mechanical concerns centre around the injection-driven fluctuations in fluid pressure, although mineral reactions and pre-injection drilling of wells also have geomechanical implications that can potentially be significant. In this chapter, the focus is solely on the important geomechanical phenomena at the Otway Project that are related to the injection of CO_2.

Injection of CO_2 invariably results in some degree of fluid over-pressurisation with respect to the prevailing pressure profile. If the system is pressurised sufficiently, then a number of deleterious effects may occur, such as fracturing of the reservoir or cap rock or reactivation of previously existing faults. These physical weaknesses in the system arise due to the pore fluid pressure counteracting the forces from the in-situ stress field and are a manifestation of a reduction in the system's effective stress state. The effective stress concept was first developed by Terzaghi (1943) for soil systems, where an increase in pore fluid pressure results in an equally reduced effective stress on the rock mass (Engelder 1992). The implication of reduced effective stresses on the three principal stress axes is that the shear/normal stress ratio increases on virtually all imaginary planes in the system, which essentially means that the system is closer to failing in shear mode (Figure 7.1). Similarly, elevated fluid pressures also shift the system closer to the tensile failure condition, where the fluid pressure is equal to or greater than the minimum principal stress.

The influence of fluid pressure on the effective stress state of the system is the main reason why injectivity is such an important issue for a CCS project. Reservoirs with a large storage capacity and high permeability help to ensure that CO_2 can potentially be injected at high rates, while minimising the increase in fluid pressure and preserving the mechanical integrity of the reservoir, cap rock and any faults in the vicinity of the injected CO_2. However, reservoir rocks with these favourable characteristics are