INTRODUCTION

The Grüneisen parameter is an important quantity in geophysics as it often occurs in equations which describe the thermoelastic behavior of materials at high pressures and temperatures. The value for γ is used to place constraints on geophysically important parameters such as the pressure and temperature dependence of the thermal properties of the mantle and core, the adiabatic temperature gradient and the geophysical interpretation of Hugoniot data.

The Grüneisen parameter has considerable appeal to geophysicists because it is an approximately constant, dimensionless parameter that varies slowly as a function of pressure and temperature. It has both a microscopic and macroscopic definition, the former relating it to the vibrational frequencies of atoms in a material, and the latter relating it to familiar thermodynamic properties such as heat capacity and thermal expansion. Unfortunately, the experimental determination of γ, defined in either way, is extremely difficult; the microscopic definition requires a detailed knowledge of the phonon dispersion spectrum of a material, whereas the macroscopic definition requires experimental measurements of thermodynamic properties at high pressures and temperatures. As a result of the difficulty associated with obtaining experimentally an accurate value for γ, a number of more approximate expressions have been suggested (see Poirier 1991 for a review). Many of these expressions relate γ at atmospheric pressure (P = 0) to the first derivative of the bulk modulus with respect to pressure (K’), via γ = 1/K’ - x, where x is a constant. These relations may be expanded to take into account the variation of γ with pressure. In these more general cases, γ(P) is a function of the equation of state. Despite the intrinsic relationship between γ and the EOS (see, for example, Irvine and Stacey 1975), it is frequently the case that the choice of the functional form of both the Grüneisen parameter and the equation of state to which it should be related are made independently of each other and somewhat arbitrarily; this has resulted in a literature in which there is a wide range of values of γ for many geologically relevant materials.