GY403 Lithostatic Stress Example Problem

Given:

Assume a $1cm^3$ volume of continental crust is buried to a depth of 5 kilometers. The density if the material and all of the surrounding crust is $2.8g/cm^3$.

Calculate:

(1) The value of the lithostatic stress on the $1cm^3$ cube of material in terms of kilobar.

(2) The stress gradient in terms of kilometers per kilobar.

From the description of the problem, and consideration of a fundamental physical laws, we know the following:

a = acceleration due to Earth's gravitational field = 980 cm/sec^2
$\rho = 2.8g/cm^3$

To solve for the stress:
$F=ma$
$F=\rho Va$
{V = volume of the overburden column}
$F=\rho hba$
{h = height of overburden column; b = area of base of column}
$F = (2.8g/cm^3)(5.0x10^5cm)(1.0cm^2)(980cm/sec^2)$
$F = 1.372 \times 10^9$ g cm/sec^2
$F = 1.372 \times 10^9$ dynes

$\sigma = F/A = (1.372 \times 10^9 \text{ dynes} / 1.0 \text{ cm}^2)$
$\sigma = (1.372 \times 10^9 \text{ dynes} / 1.0 \text{ cm}^2) \times (1 \text{ bar} / (1x10^6 \text{ dynes} / \text{cm}^2)) = 1.372 \times 10^3$ bar
$\sigma = 1.372$ kilobar

Lithostatic Stress Gradient

5.0 kilometers / 1.372 kilobar = 3.64 kilometers / kilobar