# GG 5500 Numerical Methods in the Geosciences
## Computer Assignment #5:
## Numerical Integration/Using Functions

Assigned: February 10, 2005
Due: February 17, 2005

Relevant reading: Lindfield and Penny, Chapter 4.

The vertical velocity of fluids moving upward in a pipe can be described as function of the pressure gradient ($\Delta P/L$), fluid viscosity ($\mu$), and radius of the pipe (r and R). (R is the total radius).

$$V_z = \frac{\Delta P R^2}{4\mu L}\left[1 - \left(\frac{r}{R}\right)^2\right]$$

The average velocity in the pipe can be determined by integrating the value of $V_z$:

$$\overline{V}_z = \frac{\int_0^{2\pi}\int_0^R V_z\, r\, dr\, d\theta}{\int_0^{2\pi}\int_0^R r\, dr\, d\theta} = \frac{\Delta P R^2}{8\mu L}$$

This lesson will also introduce the general use of functions and illustrate how the amount of computer resources required to solve various problems can be determined.

1. Use the function **simp2** or **simp1** (given on p. 167 of Lindfield and Penny) to evaluate the integral shown above for the average velocity of basalt moving up a volcanic pipe with a radius of 10 m.. Assume the following parameters: pressure gradient, $\Delta P/L$, is 100 kg $m^{-2}s^{-2}$ and fluid viscosity, $\mu$, is $10^3$ Pa S ($kgm^{-1}s^{-1}$). Find the appropriate number of Simpson rule intervals so that this method is within $10^{-6}$ of the value given by the exact solution of the integral ($\Delta PR^2/8\mu L$)

2. Use the function **Gauss_quad** (which will be e-mailed to all of you) to calculate the value of the integral using a variety of quadrature points. As with problem 1, determine the number of quadrature points so that this method is within $10^{-6}$ of the value given by the exact solution.