The "in situ" density is given by:

$$\rho(s,\theta,p) = \frac{\rho(s,\theta,0)}{\left[1 - \frac{p}{K(s,\theta,p)}\right]} = \frac{\rho(s,\theta,0)\, K(s,\theta,p)}{K(s,\theta,p) - p}$$

The adiabatic and isentropic compressibility (1/Pa) is:

$$\gamma = \frac{1}{\rho}\frac{\partial\rho}{\partial p}\bigg|_{s,\theta} = \frac{1}{\rho c^2} \qquad c^2 = \frac{1}{\rho\gamma} \qquad \gamma: \frac{m^2}{N} = \frac{ms^2}{kg}$$

$$\gamma = \frac{(K-p)\rho_0 \frac{\partial K}{\partial p} - \rho_0 K \frac{\partial}{\partial p}(K-p)}{\rho(K-p)(K-p)}$$

$$\gamma = \frac{(K-p)\rho \frac{\partial K}{\partial p} - \rho_0 K \frac{\partial K}{\partial p} + \rho_0 K}{\rho(K-p)(K-p)}$$

$$\gamma = \frac{\cancel{K\rho_0 \frac{\partial K}{\partial p}} - p\rho_0 \frac{\partial K}{\partial p} - \cancel{\rho_0 K \frac{\partial K}{\partial p}} + \rho_0 K}{(K-p)(K-p)}$$

$$\boxed{\gamma = \frac{\rho_0\left(K - p\frac{\partial K}{\partial p}\right)}{\rho(K-p)(K-p)}} \qquad \boxed{\gamma = -\frac{0.1\rho_0\left(Z\frac{\partial K}{\partial p} - K\right)}{\rho(K+0.1Z)^2}}$$

or

$$\frac{1}{c^2} = \frac{\overbrace{\frac{\rho_0 K}{(K-p)}}^{\rho}\left(1 - \frac{p}{K}\frac{\partial K}{\partial p}\right)}{K\left(1 - \frac{p}{K}\right)}$$

or

$$\boxed{\frac{1}{c^2} = \frac{\rho(s,\theta,p)}{K(s,\theta,p)}\,\frac{\left(1 - \frac{p}{K}\frac{\partial K}{\partial p}\right)}{\left(1 - \frac{p}{K}\right)}}$$