effective impurity potential accounting for electron screening is given by

$$v(q) = v_0(q)/\varepsilon(q) \,. \tag{5}$$

Here $v_0(q)$ is the Fourier transform of $v_0(r)$

$$v(q) = -4\pi U \frac{\sin q r_s - q r_s \cos q r_s}{q^3}, \tag{6}$$

and $\varepsilon(q)$ is the dielectric constant in the random phase approximation.

$$\varepsilon(q) = 1 + \frac{4 e^2 m k_F}{\pi \hbar^2 q^2}\left[\frac{1}{2} + \frac{k_F}{2q}\left(1 - \frac{q^2}{4 k_F^2}\right)\ln\left|\frac{q + 2 k_F}{q - 2 k_F}\right|\right], \tag{7}$$

where k_F is the Fermi wave vector. If it is assumed that the Fermi surface is spherical (i.e. neglecting the neck electrons in the noble metal alloys) the resistivity can be calculated from [16]

$$\varrho_0 = \frac{c\,(1-c)\,m^2}{4\pi\hbar^3 k_F^3}\int_0^{2k_F} |v(q)|^2 q^3 \,\mathrm{d}q \,, \tag{8}$$

where c is the concentration of Au atoms.

The volume derivative of (8) is easily shown to be

$$\frac{\mathrm{d}\ln\varrho_0}{\mathrm{d}\ln V} = -5\frac{\mathrm{d}\ln k_F}{\mathrm{d}\ln V} - 2\frac{\displaystyle\int_0^2 \mathrm{d}x \frac{(\sin\alpha x - \alpha x\cos\alpha x)^2}{x^3\varepsilon^2(x)}\frac{\mathrm{d}\ln\varepsilon(x)}{\mathrm{d}\ln V}}{\displaystyle\int_0^2 \mathrm{d}x \frac{(\sin\alpha x - \alpha x\cos\alpha x)^2}{x^3\varepsilon^2(x)}}, \tag{9}$$

where $x \equiv q/k_F$, $\alpha \equiv k_F r_s$,

$$\frac{\mathrm{d}\ln\varepsilon(x)}{\mathrm{d}\ln V} = \frac{1}{3}\left[1 + \frac{\pi\hbar^2 k_F}{2 m e^2}\left(\frac{x^2}{1 + \dfrac{(1 - x^2/4)}{x}\ln\left|\dfrac{1+x/2}{1-x/2}\right|}\right)\right]^{-1}, \tag{10}$$

and U is assumed to be independent of volume and concentration. In the free electron approximation $\mathrm{d}\ln k_F/\mathrm{d}\ln V = -1/3$. The integrals can be evaluated numerically if k_F and r_s are known; for both Ag and Au $k_F = 1.20$ Å^{-1} and $r_s = 1.59$ Å [18]. Evaluating the integrals yield $\mathrm{d}\ln\varrho_0/\mathrm{d}\ln V = 1.38$ for all Ag–Au alloys. As seen in Table 1 this is in general agreement with the experimental values; however, this model does not predict the concentration dependence. A similar calculation using this model was made for the Cu–Ag and Cu–Au alloys; in these cases the model predicted both the wrong sign and magnitude (in the case of the pseudopotential calculations [15] agreement between theory and experiment was obtained for the Cu–Ag alloys, but not the Ag–Au alloys).

These discrepancies in the theoretical prediction (from both models) are not too surprising because the effect of the low lying filled d-bands on the scattering potential was not explicitly considered. It is well known that the filled d-bands in the noble metals strongly interact with the conduction electrons in certain directions [1, 17]. From optical measurements [19] it has been shown that the d-levels of Cu and Ag do not overlap and form separate d-states in the alloys,