# Author's Reply

Keeping in mind that this work was carried out in 2004-05 when the Hydrogeophysics was just emerging, this work is of the interest of many researchers working in groundwater exploration and management especially in hard rock terrains. Recent published works suggest that the establishing relationship between hydraulic conductivity (K), transmissivity (T)) and geophysical parameters (depth of aquifer (z), resistivity ($\rho$)) is the base of groundwater flow modelling of aquifer parameters by integrating geophysical and geohydrological properties mathematically (Joint-inversion) or logically and is of growing interest. The work reported here suggests that relationship between K and $\rho$ estimated from vertical electrical sounding (VES) is strictly nonlinear in hard rock and alluvium aquifers. However, in alluvium aquifer a linear relationship can be obtained where there are no large variations in subsurface geology. Exponential relationships could be used for any aquifer systems for interpolating or extrapolating T and K for water resources management. Exponential relationship is further supported by Batte et al (2010) in hard rock terrain of Central Uganda. They have found that the linear relationship between $\log K$ and $\rho$, which is similar to exponential relationship have been found in Osmania University Campus (OUC). Their results support that the site specific constants A and B ($K = Ae^{B\rho}$) could be negative.

There are some limitations of geophysics in estimation of subsurface properties in cases like presence of clay layer which is conductive but less permeable. Such problems could be overcome by incorporating priory information about the lithologies by other means (lithologs etc.). Nonlinear equation developed by Revil and Glover (1997) and Revil et al. (1998) for shaley sand aquifer based on the ionic concept cannot be used to interpret field data. Niwas et al. (2006) have also pointed out that this equation cannot be used for interpreting field/observed data. Niwas et al (2006) have approximated the conductivity equation for shaly sand aquifers for interpreting observed data. Results reported by them suggest that K and $\rho$ have the nonlinear relationship and is in agreement with finding of present research work. However, these studies are not related to hard rock aquifers which are more complex but still indicate the possibility of existence of nonlinear behaviour of hydraulic parameters with geoelectrical parameters similar to those were found in hard rock aquifers.

Relationships between hydraulic parameters (K and T) and electrical parameters of the aquifer estimated from geophysical observations provide vital information for groundwater flow modelling and water resources management. As pointed out by the reviewer, both the equations for fluid and electrical flow are analogous in steady states but these may deviate due to fracture geometry and density in the crystalline aquifer. Thus, it is very difficult to derive a theoretical expression for dependency of K on $\rho$ in crystalline aquifer systems and therefore, site specific relationships have been established between K and $\rho$ by correlating the existing and new hydraulic and geoelectrical parameters. These relationships then used to compute K and T at VES locations. Transmissivity and resistivity maps were prepared after interpolating the K and

aquifer thickness (b) and $\rho$ over the entire area. Kriging interpolation (Cressie 1993, Isaaks and Srivastava 1989), a method of interpolation which predicts unknown values from data observed at known locations, has been used to interpolate K, and aquifer thickness (b) and $\rho$.

In addition to this, published data of different part of the world have been examined whether the similar relationships between K and $\rho$ found in OUC, exist in other parts of the world in hard rock and alluvium aquifers. This study supports the fact that the behaviour of K in crystalline aquifer is highly nonlinear (exponential) and such nonlinear equations by calibrating with experimental data of K and $\rho$ could be useful for obtaining transmissivity distribution of aquifer(s) in the area of investigation. This map can be used for installing exploratory wells for water supply and water resources management.

Geology of the area is composed of Hyderabad granites of Archean age. Granite and granitic soil are exposed on the surface at several locations. The topography of the area has gentile slope. Most of the area is covered with vegetations. The study area is very small (~9 $km^2$).

I agree with reviewers 1 and 2 for their comments that the references quoted are very old. I also noticed that text and equation are repeated in online version of the paper. However, this was not there in original manuscript. I agree with the anonymous reviewers for spelling mistakes and editing error probably during setting for publication (repeated text and equations) and these errors can be fixed in final version of the manuscripts.

## References


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