MRS AND ELECTRICAL IMAGERY FOR CHARACTERISING WEATHERED AND FRACTURED HARD-ROCK AQUIFER IN THE MAHESHWARAM WATERSHED, HYDERABAD, INDIA

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INTRODUCTION

Magnetic Resonance Sounding (MRS) and Multi Electrode Resistivity Imaging (MERI) studies were carried out for characterizing weathered and fractured aquifer in a granitic terrain in Maheshwaram watershed located 30 km south of Hyderabad (India). It is main study area of the Indo-French Centre for Groundwater Research (BRGM- NGRI collaboration project). It has a surface area of about 60 km², between Latitudes $17^0$06'20"N to $17^0$11'00"N and Longitudes $78^0$24'30"E to $78^0$29'00"E. The watershed is mainly constituted of Archean granites with isotropic texture having some dolerite dykes and quartz veins. The weathering profile is generally truncated by erosion: alterite thickness is less than 5 meters and horizontal fractures are well-developed in the fissured/fractured zone whose average thickness is about 25 m. Due to overexploitation of groundwater resources, aquifer is mainly developed in this fractures/fissured zone where vertical fracture of tectonic origin also exists. The water table depth vary from a few meters to more than 20 m from place to place and depending on the season (seasonal variations due to rainfall recharge may reach 10 m).

INVESTIGATIONS

Various geophysical investigations were carried out in the watershed since 1999 which include: Resistivity soundings with Schlumberger configuration, Resistivity and Magnetic profiling across dykes, Well-logging, Mise-a-la-masse and S.P. studies. Preliminary MRS, Electrical Imaging and Time Domain EM reconnaissance were undertaken in two locations (one at Mohabbatnagar and the other at KB Tanda) in November 1999, at a high water level, during post monsoon period. The sites investigated are shown in Fig.1. The cultural noise was found to be high during certain period of the day, whereas, the actual signal level is rather low. This tedious signal to noise conditions could be improved with an adapted measurement planning and by using the newly developped notch filter centered on 50-Hz-harmonics (Legchenko and Valla, 2003). The results of MRS and Resistivity Imaging have been compared along the two profiles and are discussed here.

RESULTS

On KB Tanda site, the cross section infrerred from MERI and MRS studies is shown in Fig.3. The resistivity cross-section define on its western side a well identified high resistivity mole and a high resistivity superficial spot in perfect accordance with surface observation of massive hard rock outcrop and boulders. As no MRS signal is observed in this area, this zone is interpreted as an unweathered, low water content massive rock, may be subjected by a fault. On the main central and eastern part of the profile, low resistivity and very low resistivity are observed at shallow depth, probably caused by clayey alterites in coherence with the mainly low value of decay time T2* defined by MRS. The high water content and longer decay time suggest that the largest amount of water is stored in the northwestern part of the profile (IPMR9,IPMR11). The maximum thickness of water-saturated weathered zone was found to be about 15m. A relatively short decay time and low water content (IPMR3) is most probably caused by a greater amount of clay or silt in the weathered zone. In depth, resistivity shows a gradual increase up 300-400 Ohm.m at 20 m depth.

On Mohabatnagar site, the resistivity profile indicates two vertical conductive zones (Fig.2) located at distances 55m and 190m. The second one extends laterally also at shallow depth. The cross section derived from the MRS results is also shown in the same figure. It shows the water content and the decay time. The upper part of PMR7 and PMR10 and the main part of IPMR13 may be due to alluvial deposits. The underlying probable weathered zone increases from almost non-existent on IPMR 13 to reach the thickness of 20m for a maximum depth of 25 m on IPMR10. A relatively long signal decay time reveals a small amount of clay in the weathered zone. The second conductive anomaly on resistivity section corresponds to a lineament detected on aerial photographs and at the same time identified as high water content from MRS.

At both the sites the 200 Ohm.m iso-resistivity curve show a good correlation with the 1-2% contour at the base of the water-bearing layer. The profiles of MRS water-content versus depth are characterised by high water content at the top and a gradual decrease with depth. MRS defined water-bearing layers of 1 to 8 % water content extending from a few meters depth down to 10-15 m except in the north of Mohabatnagar site where it is 25m. Based on open well and borehole data, it appears that this layer correspond to the water saturated weathered zone and the upper part of the fractured zone.

CONCLUSIONS

The resistivity imaging has helped in identifying certain fault zones, which exist in both sites. The MRS show a main water-bearing layer extending from the surface or a few meters depth down to 15-30m. Based on open well and borehole data it appears that this water layer mainly correspond to the water saturated weathered zone. Thus the preliminary experiment on the Maheshwaram basin show a very good agreement between resistivity imaging and MRS results and show the possibility of combined geophysical investigation for:

- evaluating water ressources in weathered as well as in the fractured zone,
- delineating water bearing structures.

ACKNOWLEDGEMENTS

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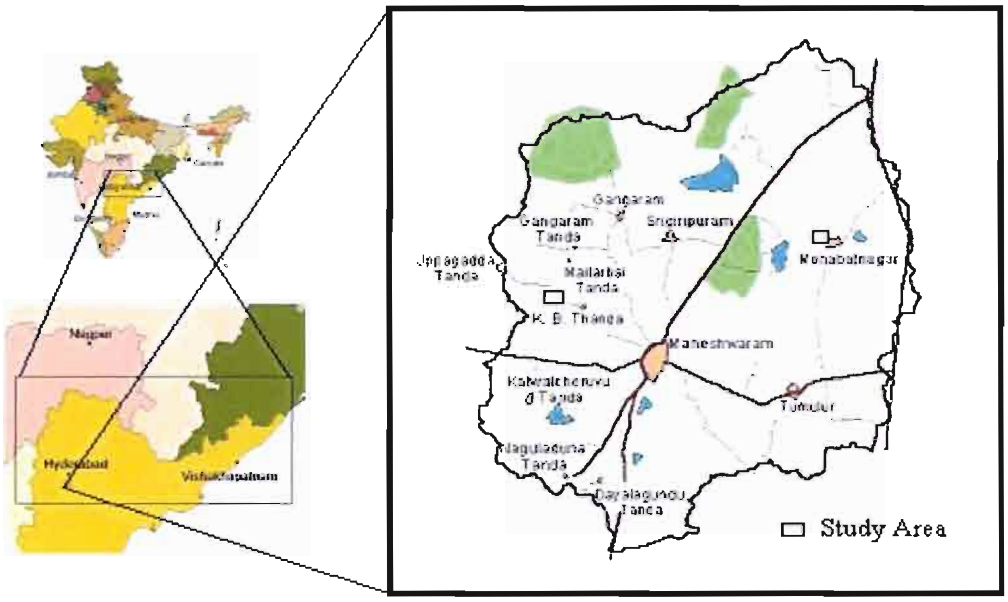

Figure 1: Location of the Maheshwaram basin.

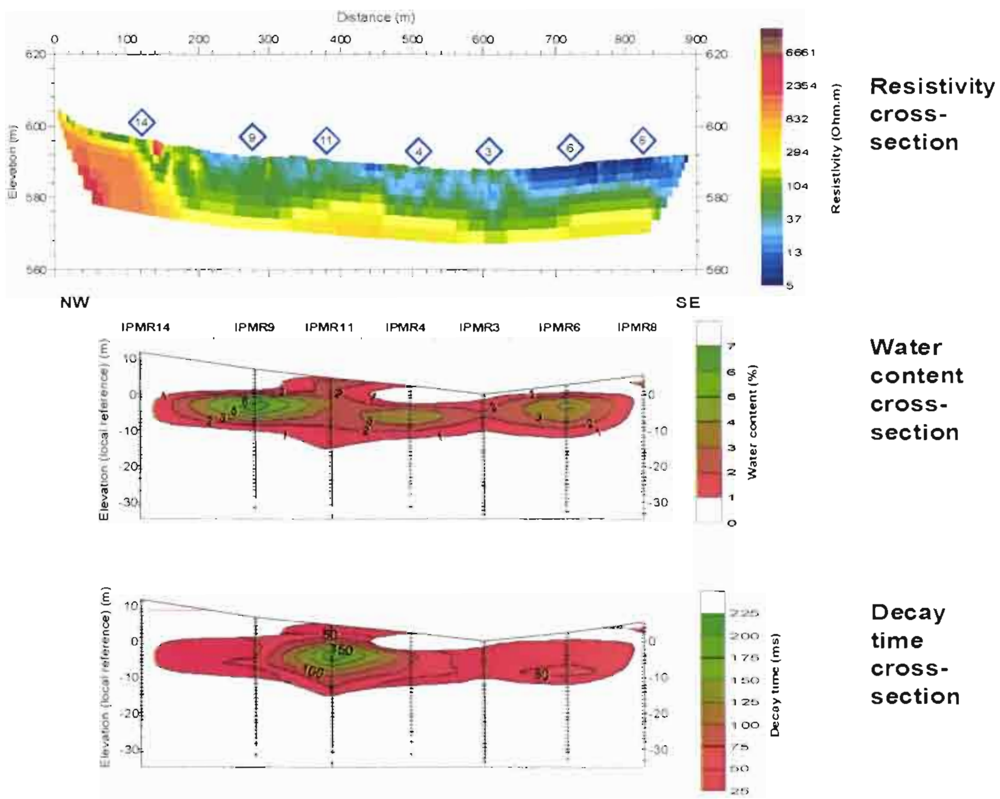

Figure 2: MRS and geoelectrical cross-section on KBTanda site.

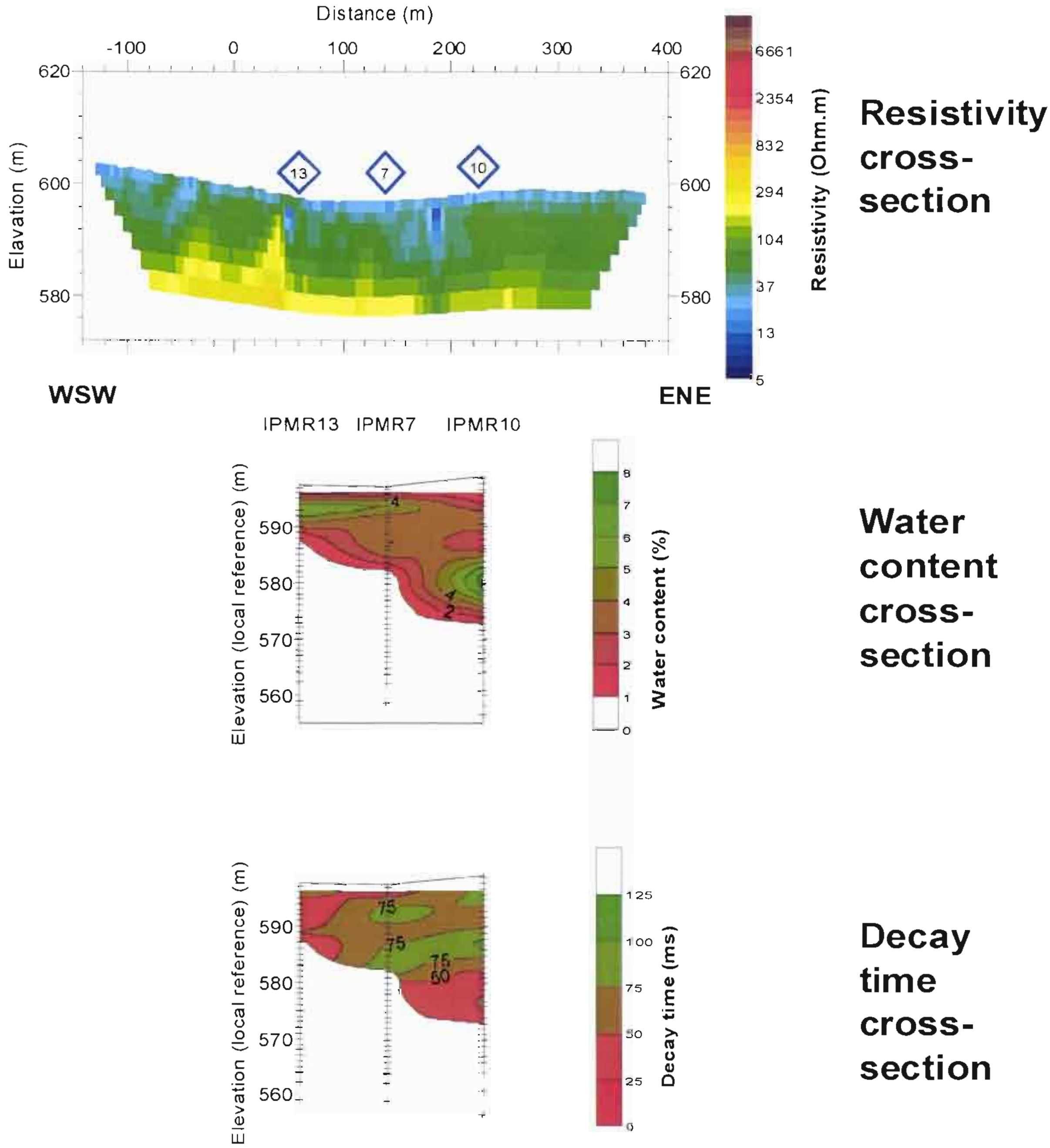

Figure 3: MRS and geoelectrical cross-section on Maohabatnagar site.

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