CHAPTER - VII

SUMMARY, DISCUSSIONS & CONCLUSIONS
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SUMMARY - DISCUSSIONS - CONCLUSIONS

7.1 SUMMARY

(i) The groundwater behaviour is erratic in hard rock aquifer systems owing to the

- Polyphase metamorphism and the related variations on the lithologies
- Multiple and varying degrees of deformation and the related greater variance in secondary porosity (fractures) and
- Varying degrees of weathering and its induced heterogeneities in the thickness of subsurface geology / regolith

Hence, even after the advent of many modern technologies, the success rate in groundwater targeting is comparatively less. Hence, the present research study has been undertaken to evaluate the relation between the geological variables and the aquifer variables and to bring out spatially and statistically the control of geological variables over the groundwater systems by taking a typical test site in hard rock area from central Tamil Nadu.

(ii) To achieve the said objectives, GIS based spatial data bases were generated on the various aquifer parameters such as

- Water level
- Transmissivity
- Permeability
- Storage co-efficient
- Specific capacity
- Optimum yield
- Width of aquifer depletion
- Recovery rate and
- Overall aquifer performance
Similarly, various spatial data bases were also generated on geological variables such as

- Lithology
- Lineaments
- Geomorphology and
- Different sub variables of subsurface geology

Then the spatial data bases on various aquifer parameters were superposed over each of the geological variable independently and from the percentage of aerial coincidence of aquifer maxima zones with geological variables and their maxima zones, the relation between the aquifer parameters and the geological variables were brought out.

(iii) GIS overlaying of various aquifer parameters over the lithology has indicated that most of the aquifer maxima zones of the above 9 aquifer parameters have fallen in Fissile hornblende biotite gneiss indicating that this lithology controls the aquifer behaviour (Table 3-1).

But at the same time, by and large, there is no much difference in the primary porosity in between fissile hornblende biotite gneiss and the other dominant lithology, charnockite. So it was concluded that lithology may not have much control over the groundwater behaviour.

(iv) The GIS overlay technique between the above 9 aquifer parameters and the lineament maxima zones has indicated an overall 38.44 percentage of spatial coincidence between the lineament maxima and the aquifer maxima. Though this is not an appreciable correlation, there appears to be some parallelism between the maxima zones of many aquifer variables and the maxima zones of the NW - SE and NE - SW lineament densities (Table 3-2).

From the same, it was surmised that the NW - SE and NE - SW trending lineaments must be broadly controlling the aquifer performance in the area.

(v) The GIS integration of spatial data on the aquifer maxima and the geomorphology has suggested that most of the aquifer maxima were coinciding predominantly with buried pediment deep and buried pediment medium and to some minimal extent with the flood plains (Table 4-1).
(vi) Similar GIS overlay analysis between the aquifer maxima zones and the maxima zones of the thickness of top soil, thickness of weathered zone and thickness of fracture zone and their various cumulative thicknesses have indicated that only the storage co-efficient seems to have been controlled by the thickness of subsurface geology (Table 5-8).

(vii) As the above GIS analyses between the aquifer parameters and the different geological variables have indicated only marginal correlation and at the same time, as there appeared to be some coincidence between the aquifer maximas and the lineament density maximas of NW - SE and NE - SW trending lineaments, it was envisaged to have detailed studies between the lineaments of different orientations and the various aquifer parameters.

a) For the same, numerical data bases were generated for 576 grids of 2.25 sq.km each on the above 9 aquifer variables / parameters.

b) Then the lineaments were azimuthically grouped into 18 classes of 10 degrees each from West to East and numerical data bases were generated similarly for 576 grids and individually for the densities of such 18 classes of lineaments.

c) Then the factor varimax analyses were carried out by notionally keeping the 576 values of each aquifer variable as the dependent variable and the corresponding 576 numerical values of 18 azimuthal classes of lineaments as the independent variables. From the same whichever lineament class have more loading of Eigen vectors with the positive sign, those were considered as the lineaments which are controlling the respective aquifer parameter / variable.

d) This was done independently between each of the aquifer variable (dependent) and the 18 lineament variables (Independent).

e) Such statistical analysis has revealed that most of the vital aquifer parameters like transmissivity, specific capacity, optimum yield, width of aquifer depletion, recovery rate and overall aquifer performance have shown maximum correlation with NE - SW trending lineaments indicating that these lineaments control these parameters.
f) On the contrary, the aquifer parameters like water level, permeability and storage co-efficient seem to be controlled by the NW - SE trending lineaments.

g) From the same, it was concluded that the lineaments / fractures play a dominant role in controlling the performance and behaviour of aquifers in the hard rock aquifer systems in general and the

- NE - SW trending lineaments are the good flowage and yielding zones and
- NW - SE lineaments are the good storage media in the area in particular.

7.2 DISCUSSIONS AND CONCLUSIONS

The studies carried out for groundwater targeting in hard rock aquifer system in general and Tamil Nadu in particular, were mostly through field based hydro geological mapping, remote sensing based geomorphological studies, geophysical resistivity applications, aquifer parameter evaluation and GIS based studies (Section 1.2.2). These different technologies have definitely brought out significant informations. But, no comprehensive picture has so far been brought out on the groundwater behaviour of the hard rock aquifer systems. The post Remote Sensing era has however laid greater emphasis on hydro geomorphic mapping for groundwater targeting.

The studies of lineaments were carried out both locally as well as regionally by a few workers (Section 1.2.3). As far as regional lineaments are concerned, some attempts have also been made to correlate the regional groundwater flow with lineaments of different ages.

Under this scenario, the present study is new from the methodology point of view as well as output point of view. In the present study, a unique methodology was followed to correlate spatially of the nine aquifer parameters (8 aquifer individual parameters and 1 over all aquifer performance) individually with lithology, lineaments, geomorphology and subsurface geology, capitalising the advanced virtues of geospatial technology.

Such geospatial modeling has brought many new genetic information (Table 7-1). The analysis between the lithology and the aquifer parameters showed that overall almost
all the aquifer parameters have positive correlation with Fissile Hornblende Biotite Gneiss with average area percentage of coincidence of 83.25 in contrast to Charnockite which shows only 16.28% of aerial coincidence with aquifer parameters data. However, amongst various aquifer parameters recovery rate, permeability and optimum yield showed the coincidence of more than 87 aerial percentage with Fissile Hornblende Biotite Gneiss. This suggests that owing to comparatively more fracturing and weatherability, the Fissile hornblende biotite gneiss has better groundwater holding and conducting capacity.

The spatial analysis between the maximas of aquifer parameters and the maximas of lineament density indicated that the maximas of specific capacity showed an aerial percentage of coincidence of 72 with lineament maxima and permeability to the tune of 59.90% (Table 7-1).

Again the GIS based spatial correlation between an aquifer maxima of 9 aquifer parameters and geomorphology showed that Buried pediment deep has the maximum area of coincidence with maxima of aquifer parameters when compared to other geomorphic units. This can be attributed to high thickness of weathering. However, amongst different aquifer parameters, storage coefficient (65.68%), Transmissivity (61.28%) and optimum yield (61.02%) showed maximum area percentage of coincidence (Table 7-1) which confirms the above observations. In the case of sub surface geology too, the storage coefficient maxima shows maximum area of coincidence with maxima of topsoil, weathered zone and fractured zone.

During the spatial analysis between lineament maxima and the aquifer variables, the area of coincidence between the lineament maxima and the maxima of transmissivity and optimum yield showed a NE – SW orientation (Fig. 6.17 and 6.25) where as with permeability and specific yield, the areas of coincidence were aligned in NW – SE direction. (Fig. 6.19 & 6.23). Stimulated by this, when spatio linear modeling studies were carried out by azimuthally classifying the lineaments into 18 classes of ten degrees each and using applied probability statistics, the same has revealed significant information that

- Transmissivity, Specific Capacity, optimum yield etc are controlled by NE – SW lineaments (Fig. 6.32, Table 6 – 12) and
- Water level and permeability are controlled by NW – SE lineaments (Table 6 – 12, Fig.6.32)
## Table – 7-1

**Geosystem Parameters Vs Aquifer Parameters**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Aquifer Parameters</th>
<th>Lithology</th>
<th>Geomorphology</th>
<th>Subsurface Geology</th>
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<tr>
<td></td>
<td></td>
<td>Charnockite</td>
<td>BPD</td>
<td>BPM</td>
</tr>
<tr>
<td>1</td>
<td>Water Level Minima</td>
<td>43.0</td>
<td>55.19</td>
<td>19.54</td>
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<tr>
<td>2</td>
<td>Transmissivity Maxima</td>
<td>0.0</td>
<td>100</td>
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<tr>
<td>3</td>
<td>Permeability</td>
<td>1.48</td>
<td>98.62</td>
<td>59.90</td>
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<td>4</td>
<td>Storage Coefficient Maxima</td>
<td>23.86</td>
<td>76.14</td>
<td>39.45</td>
</tr>
<tr>
<td>5</td>
<td>Specific Yield Maxima</td>
<td>0.0</td>
<td>100</td>
<td>72.0</td>
</tr>
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<td>6</td>
<td>Optimum Yield Maxima</td>
<td>12.79</td>
<td>87.21</td>
<td>34.15</td>
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<tr>
<td>7</td>
<td>Width of Aquifer Depletion Minima</td>
<td>49.05</td>
<td>49.01</td>
<td>20.07</td>
</tr>
<tr>
<td>8</td>
<td>Recovery Rate Maxima</td>
<td>0.07</td>
<td>99.93</td>
<td>34.53</td>
</tr>
<tr>
<td>9</td>
<td>Overall Aquifer Performance Maxima</td>
<td>26.05</td>
<td>72.91</td>
<td>31.82</td>
</tr>
<tr>
<td></td>
<td>Excluding Item No.9 Average</td>
<td><strong>16.28</strong></td>
<td><strong>83.25</strong></td>
<td><strong>38.44</strong></td>
</tr>
</tbody>
</table>

### Geomorphology

- BPD - Buried Pediment Deep
- BPM - Buried Pediment Medium
- BPS - Buried Pediment Shallow
- FP - Flood Plain

### Subsurface Geology

- T.S = Top Soil
- WZ = Weathered Zone
- F.Z = Fractured Zone
- TS+WZ+FZ = Topsoil and Weathered zone and Fractured zone (Depth to Bedrock)
This has convincingly demonstrated that the NE – SW fractures are the prominent conduits of groundwater movement as well as yield and the NW – SE fractures are the zones of groundwater accumulation. From the same, it has also been suggested that these NE – SW fractures can be studied in details for constructing subsurface dykes in suitable locations and diverting the water and store them in NW – SE fractures.

The studies carried out by earlier workers especially Grady (1971) showed that the NE – SW faults are deep faults in Tamil Nadu. The studies of Kumanan (1998) too indicated the vibrancy of NE – SW lineaments in conducting the groundwater in parts of southern Tamil Nadu. The studies by various workers especially Vemban et.al (1977) Ramasamy (1995) and Ramasamy (2006) have revealed that NE – SE faults are dynamically active due to post collision tectonics and the rise of carlberg's ridge. All these show that the NE – SW faults are excellent groundwater reservoirs and hence warrant still deeper studies for their effective and optimum exploitation.

Thus, the present study has brought out many newer information as well as a comprehensive picture on the groundwater behavior in hard rock aquifer systems.