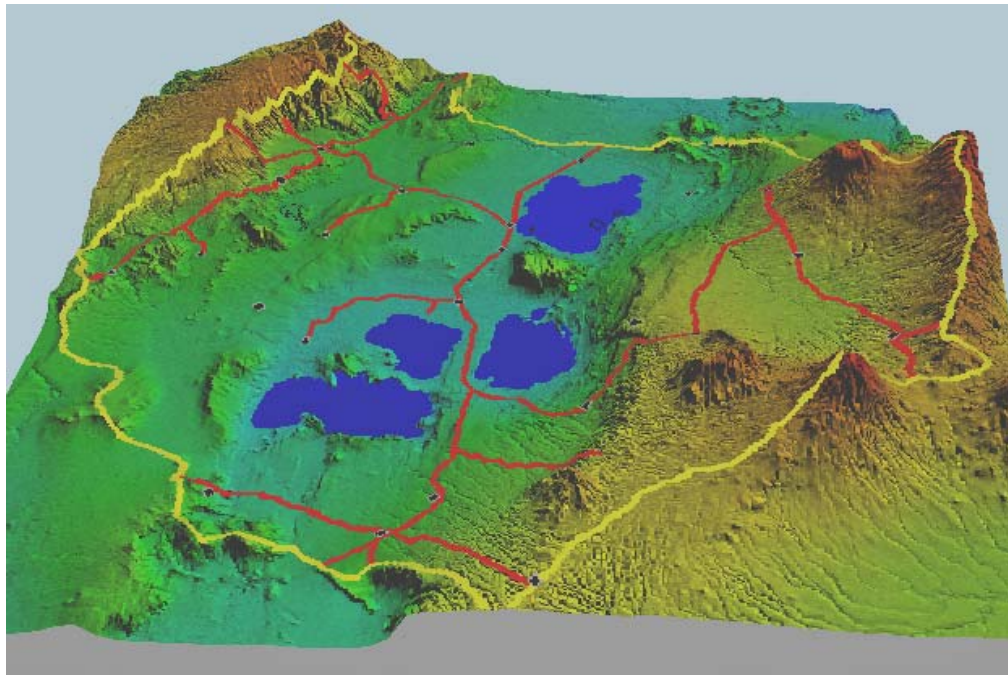


# SYSTEMATIC GROUNDWATER INVESTIGATION IN SELECTED SITES OF THE ETHIOPIAN RIFT: TOWARDS AN UNDERSTANDING OF THE HYDROGEOLOGY OF THE RIFT AND ADJACENT HIGHLANDS

## PHASE-II PROGRESS REPORT



*Prepared By*

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**Addis Ababa University, Department of Earth Sciences**

**Nov. 2006**  
**Addis Ababa**

### 1. Title of the Project:

Systematic groundwater investigation in selected sites of the Ethiopian Rift:  
Towards an understanding of the hydrogeology of the rift and adjacent highlands

2. Team Leader: Dr. Tenalem Ayenew

### 3. Project Participants in the Current Mission

- a) Staff: Tamiru Alemayehu, Dagnachew Legesse, Tigistu Haile,
- b) Students
  - i) 1 Phd student (Mr. Andarge Yitbarek)
  - ii) 6 MSc Students:
- c) 10 Daily laborers

No	Name	Thesis Title	stream
1	Tibebu Terefe	Groundwater utilization from lacustrine aquifer of Ziway and and its impact on groundwater balance	Hydrogeology
2	Abiyu Kebede	Interaction between the lakes region and the Koka basin	Hydrogeology
3	Haile Asrat	Land use impact on water quality in the Main Ethiopian Rift	Hydrogeology
4	Mulugeta Mussie	Hydrogeological nature at at Gidabo-Awassa basin boundary	Hydrogeology
5	Hawi Abate	Hydrological modeling of Meki river basin	GIS & Remote Sensing
6	Binyam Tesfaw	Lineament analysis around Lake langano	GIS & Remote Sensing
7	Fekadu Tamiru	Application of Gravity and magnetic method at the Koka basin and Central Rift valley	Geophysics

From the previous batch one student from the hydrogeology stream and one student from geophysics stream are currently working on their Thesis.

#### **4. The second field mission**

- a) July 15-25, 2006
- b) Sept. 15-25, 2006

During the first period of the field work, six MSc students, Three principal investigators carried out field investigations and site selection for further detailed field survey and sampling. After two days of preliminary survey the team started to georeference the wells and collected water samples. Some of the MSc candidates are still working in the area after where they are collecting water samples and carry out geophysical measurements under the guidance of their respective advisors. During the second period Drs. Tamiru Alemayehu, Dagnachew Legesse and Tigistu Haile have participated in the field work. In this period besides well inventory, gravity and magnetic survey was carried at the boundary between lakes region and Koka basin.

#### **5. Areas of Investigation**

General introduction of the geology, surface water and groundwater condition of the Main Ethiopian Rift to the new postgraduate students was carried out for over three days. The team visited the irrigation schemes, water treatment facilities, lakes, rivers etc.

In the second phase of the project, the focus is the central Main Ethiopian Rift (MER); a topographically closed basin with five major lakes surrounded by shallow and deep groundwater system located in a complex volcanic province. The study area can be divided in to three based on their hydrogeological and geomorphological set up:

- 1) The closed lake Awassa catchment and the Upper Gidabo basin boundary
- 2) The complex closed Ziway-Shala basin at the heart of the cent of the Ethiopian rift.
3. The MER and Koka basin boundary

The first area was interesting from groundwater transfer point of view. There are numerous springs, which are recharged from upper Gidabo basin that flow towards the Awassa closed basin. The study will focus in identifying the quantity of water that flows towards Awassa basin. The main objectives are to prepare comprehensive groundwater flow map at the boundary of the two basin, hydrogeochemical characterization at the interface.



Figure 1. Location of the study area

In the second group the study is the follow up of the first phase. In the current work more detailed investigation is being carried out that is aimed at

1. Surface water (lakes, rivers) and shallow groundwater interaction
  - Groundwater utilization impact on lakes and river water
  - Role of lineament on groundwater circulation
  - Impact of landuse on water quality
2. Hydrological modelling of river

## **6. Main Objective of the Field Mission**

The research scheme in this specific region focuses on two main issues:

- 1) To understand the occurrence and distribution of groundwater in the rift and assess its role in the water balance of the rift lakes and identify large aquifer systems, which can be used by the rural and urban community that are short of potable water due to unfavorable hydrogeological conditions and bad water quality.
- 2) To investigate recharge processes, depths of groundwater circulation, flow direction, inter-basin water transfer, groundwater flow dynamics and continuity along geo-hydrologically representative section of the Plateau and rift transect.

## **7. Summarized Activities of the first field trip**

The detailed field investigation and the scientific aspects are treated in **section**. This part shows summarized activities.

- *Number of inventoried wells*:- A total of 177 new wells have been inventoried using GPS in the second phase. ( Table 1)

- *Number of samples*:- A total of 15 water samples have been collected for hydrochemical analysis. (Table 2) Chemical analysis is on progress. Water samples from Gidabo-Awassa boundary are not yet collected.
  
- *In situ water quality tests*:- In situ water quality analysis at 15 sites have been carried out. The analysis made include pH, EC, Eh and temperature (Table 2).
  
- *Other field measurements*:- Other in situ tests include groundwater level monitoring, and geophysical surveying.
  
- *Visited Sites*:- The major destination areas and routes include
  1. Meki
  2. Ziway
  3. Bulbula
  4. Awassa
  5. Leku
  6. Shashemene
  7. Butagira
  8. Adami Tulu
  9. Langano Lake
  10. Langano PA
  11. Koka
  12. Ejersa
  13. Woyo
  14. Oitu
  15. Munessa
  16. Koshe

- *Total distance traveled:-* It is quite tedious to register the distance traveled everyday as a part of research. However, we present the registered figures.

*For the first 10 days*

a) Addis Ababa-Ziway round trip for 2 cars=165 x 2x 2 cars= 660km

b) Inside the MER= 120 km/day x 2 cars x 10 days= 2400km

Sub Total=3060km

*For the second 10 days*

Sub total=3060km

Total distance traveled= 6120km

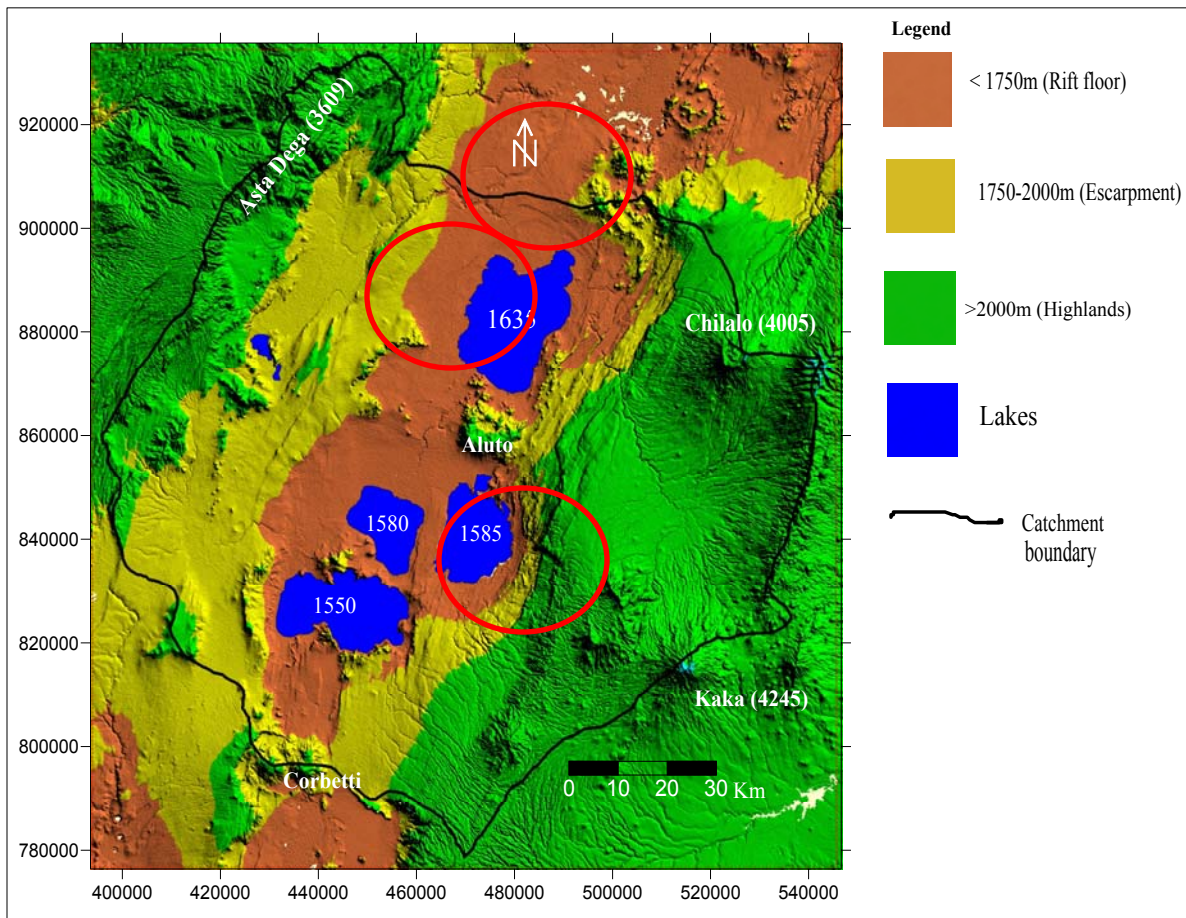


Figure 2 Lakes region with focal areas

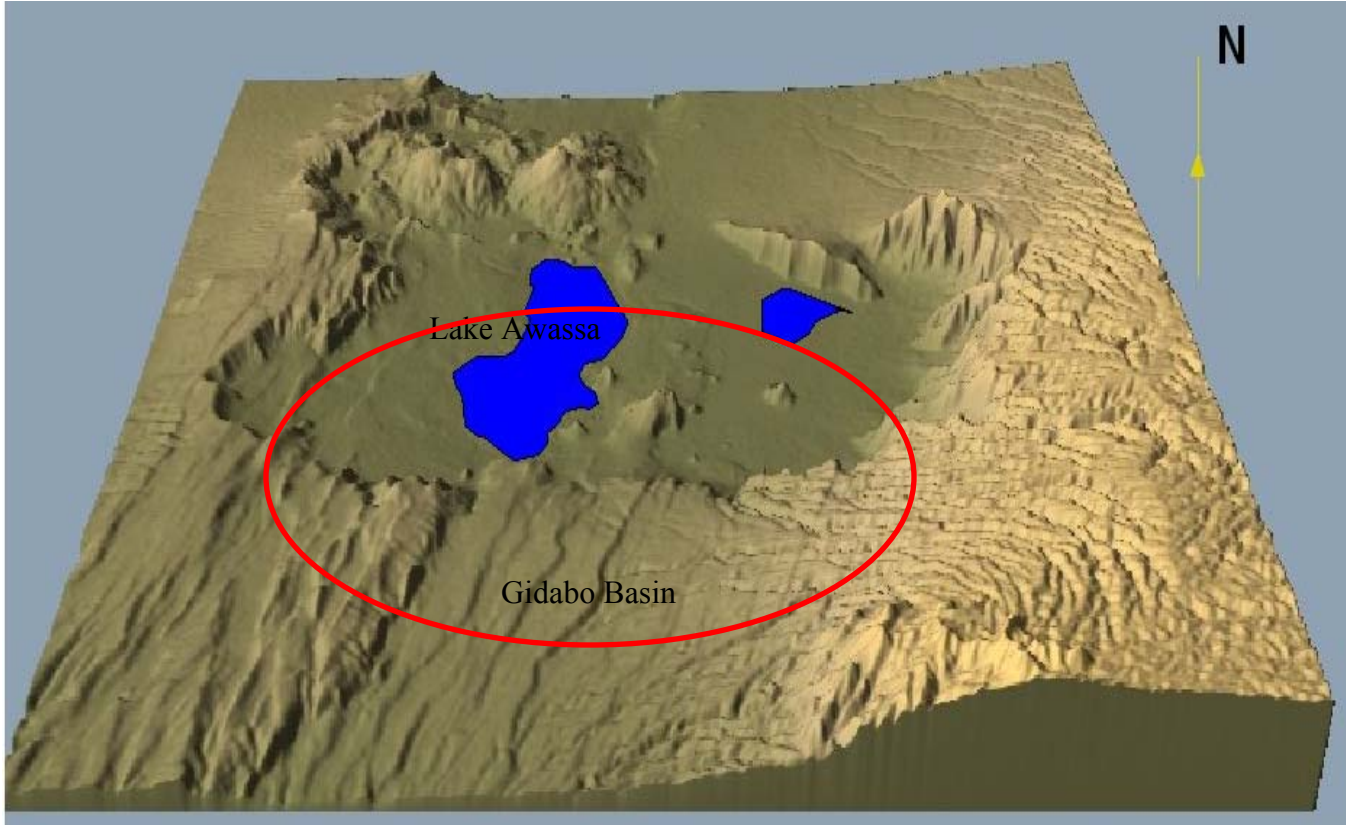


Figure 3 DEM of Awassa and Gidabo basin with focal area

Table 1. Inventory of New wells around lake Ziway

<b>NO</b>	<b>Locality Name</b>	<b>Type of Scheme</b>
1	Negashu HDW	HDW
2	Abu Geda HDW2	HDW
3	Yohanis HDW2	HDW
4	Yosef HDW	HDW
5	Iyasu HDW1	HDW
6	Iyasu HDW2	HDW
7	Iyasu HDW3	HDW
8	Denbel HDW	HDW
9	Zewdu HDW	HDW
10	Abay HDW	HDW
11	Yohanis HDW3	HDW
12	Yohanis HDW4	HDW
13	Samuel HDW	HDW
14	Roba HDW	HDw
15	Tesfaye HDW	HDW
16	Abe Qabqto HDW	HDW
17	Korme fole HDW	HDW
18	Yishak HDW	HDW
19	Sategni HDW	HDW
20	Solomon HDW	HDW
21	Tadese HDW	HDW
22	Roba Korbu HDW	HDW
23	Idaa korbu HDW	HDW
24	Korbu Jateni HDW	HDW
25	Biru HDW	HDW
26	Tedecho HDW	HDW
27	Shibiru HDW1	HDW
28	Shibiru HDW2	HDW
29	Biru HDW	HDW
30	Biyo Dekebo HDW	HDW
31	Abule HDW	HDW
32	Bali HDW	HDW
33	Abu HDW	HDW
34	Abyot HDW	HDW
35	Teshome HDW	HDW
36	Tesfaye HDW	HDW
37	Debela HDW	HDW
38	Balcha HDW	HDW

39	Buta HDw	HDW
40	Heyo HDW1	HDW
41	H/Mariam HDW	HDW
42	Badaso HDW	HDW
43	Tariku HDW	HDW
44	Bate Dodota HDW	HDW
45	Heyo HDW2	HDW
46	Hirpho HDW	HDW
47	Ashemi Bula HDW	HDW
48	Shewa Rega HDW	HDW
49	Godana HDW	HDW
50	Jara HDW	HDW
51	Tsegaye HDW	HDW
52	Husena HDW	HDW
53	Buta Gobena HDW	HDW
54	Godoba HDW	HDW
55	Necho HDW	HDW
56	Dego HDW	HDW
57	Abebe HDW	HDW
58	Jima Geda HDW1	HDW
59	Golje HDW	HDW
60	Debele HDW	HDW
61	Abure HDW	HDW
62	Hailu HDW	HDW
63	Beyemo HDW	HDW
64	Jima geda HDW2	HDW
65	Jima geda HDW3	HDW
66	Welda Oda HDW1	HDW
67	Welda Oda HDW2	HDW
68	Adi Alemu HDW	HDW
69	Tepo choro ke well	Bore hole
70	Firdu HDW	HDW
71	Zergaw HDW	HDW
72	Catholic well	Bore hole
73	Kulich HDw	HDW
74	Tamiru HDW	HDW
75	Aba Geda HDW	HDW
76	Ayele HDW1	HDW
77	Bula HDW	HDW
78	Ayele HDW2	HDW
79	Merkorewos HDW1	HDW
80	Merkorewos HDW2	HDW
81	Aba Bula HDW	HDW
82	Mamire Teferi HDW	HDW
83	Yeshi HDW	HDW

84	Aselefech HDW	HDW
85	St. Mary church HDW	HDW
86	Yirgu HDW	HDW
87	Getu HDW	HDW
88	Mebrayo HDW	HDW
89	Yeshi HDW	HDW
90	Ishatu HDW	HDW
91	Warku Like HDW	HDW
92	Kecha HDW	HDW
93	Shanko HDW	HDW
94	Dekebo HDW	HDW
95	Sida HDW	HDW
96	Wedajo HDW	HDW
97	Shasho HDW	HDW
98	Girma HDW	HDW
99	Kasu HDW1	HDW
100	Kasu HDW2	HDW
101	Kasu HDW3	HDW
102	Kasu HDW4	HDW
103	Oda bokota well	Bore hole
104	Well No 3	Bore hole
105	Graba jarso Well	Bore hole
106	Well No 1	Bore hole
107	Midekso HDW	HDW
108	Negasi HDW	HDW
109	Zerihun HDW1	HDW
110	Asefa HDW	HDW
111	Zerihun HDW2	HDW
112	Zerihun HDW3	HDW
113	Merid HDW	HDW
114	Tesfu HDW	HDW
115	Dego HDW	HDW
116	Urgecha HDW	HDW
117	Merid HDW	HDW
118	Beriso HDW	HDW
119	Begna HDW	HDW
120	Girma HDW	HDW
121	Amiya HDW	HDW
122	Sami HDW	HDW
123	Bekele HDW	HDW
124	Uga HDW	HDW
125	Tolosa HDW	HDW
126	Chewa HDW	HDW
127	Bedada HDW	HDW
128	Roba HDW	HDW

129	Nedi HDW	HDW
130	Isu Ale HDW	HDW
131	Iniyew HDW	HDW
132	Beyenech HDW	HDW
133	Temesgen HDW1	HDW
134	Nech HDW	HDW
135	Temesgen HDW2	HDW
136	W/zo Shito HDW	HDW
137	Mesfin HDW	HDW
138	Gadise Bedada HDW	HDW
139	Desta Dadi HDW	HDW
140	Abdulkadir HDW	HDW
141	Safewo HDW	HDW
142	Yasin HDW	HDW
143	Amare HDW	HDW
144	Idasa HDW	HDW
145	Kabeto HDW	HDW
146	Gemedo HDW	HDW
147	Tuke HDW	HDW
148	Bulbula health Center HDW	HDW
149	Dekebo HDW	HDW
150	Shibiri HDW	HDW
151	Mosque1 HDW	HDW
152	Denebo HDW	HDW
153	Afia HDW	HDW
154	Kedir HDW	HDW
155	Wesene HDW	HDW
156	Shanko HDW	HDW
157	Amina HDW	HDW
158	Tafese HDW	HDW
159	Mosque2 HDW	HDW
160	Adem HDW	HDW
161	Jembere HDW	HDW
162	Hale Luya Hotel HDW	HDW
163	Shimelis HDW	HDW
164	Haji Ashemi HDW	HDW
165	Dera Wako HDW	HDW
166	Welde Guta HDW	HDW
167	Ethiopia HDW	HDW
168	Municipality HDW	HDW
169	Tibeso HDW	HDW
170	Zemzem HDW	HDW
171	Abishu HDW	HDW
172	Idasa HDW	HDW
173	Aneno Well	Bore Hole

174	Adami Tulu Well No 1	Bore Hole
175	Adami Tulu Well No 2	Bore Hole
176	Abebe HDW	HDW
177	Awash hotel HDW	HDW

**Table 2- In-situ Measured Water Quality Test**

<b>N O</b>	<b>Locality Name</b>	<b>pH</b>	<b>Eh (mv)</b>	<b>Temp (°C)</b>	<b>Conductivi (µS/cm)</b>	<b>TDS (mg/L)</b>	<b>Salinity (%)</b>
1	Iyasu HDW1	6.83	-10.6	23.4	6.11	3.67	2.60
2	Abay HDW	6.56	-27.0	25	1003	589	0.70
3	Korbu Jateni HDW	6.9	-8.0	22.7	1485	900	0.80
4	Teshome HDW	6.7	-22.4	24.2	2780	1417	1.20
5	Godana HDW	6.87	-10.6	24.2	818	490	0.60
6	Tepo choroke well	7.32	-15.0	-	1425	860	0.80
7	Firdu HDW	7.2	-12.0	28.7	1685	1012	0.80
8	Zergaw HDW	7.3	-18.0	28.7	1880	1318	1.00
9	Mamire Teferi HDW	7.25	-20.0	55	1214	726	0.70
10	Warku Like HDW	7.72	-45.0	52	1051	620	0.70
11	Shasho HDW	7.4	-23.4	31.6	1600	961	0.90
12	Urgecha HDW	7.34	-19.2	27	4665	2.80	2.00
13	Gadise Bedada HDW	7.0	-1.8	30	1171	706	0.70
14	Abebe HDW	7.05	-2.0	27.8	1143	689	0.70
15	Awash hotel HDW	6.97	-3.6	21.4	4070	2.44	1.8

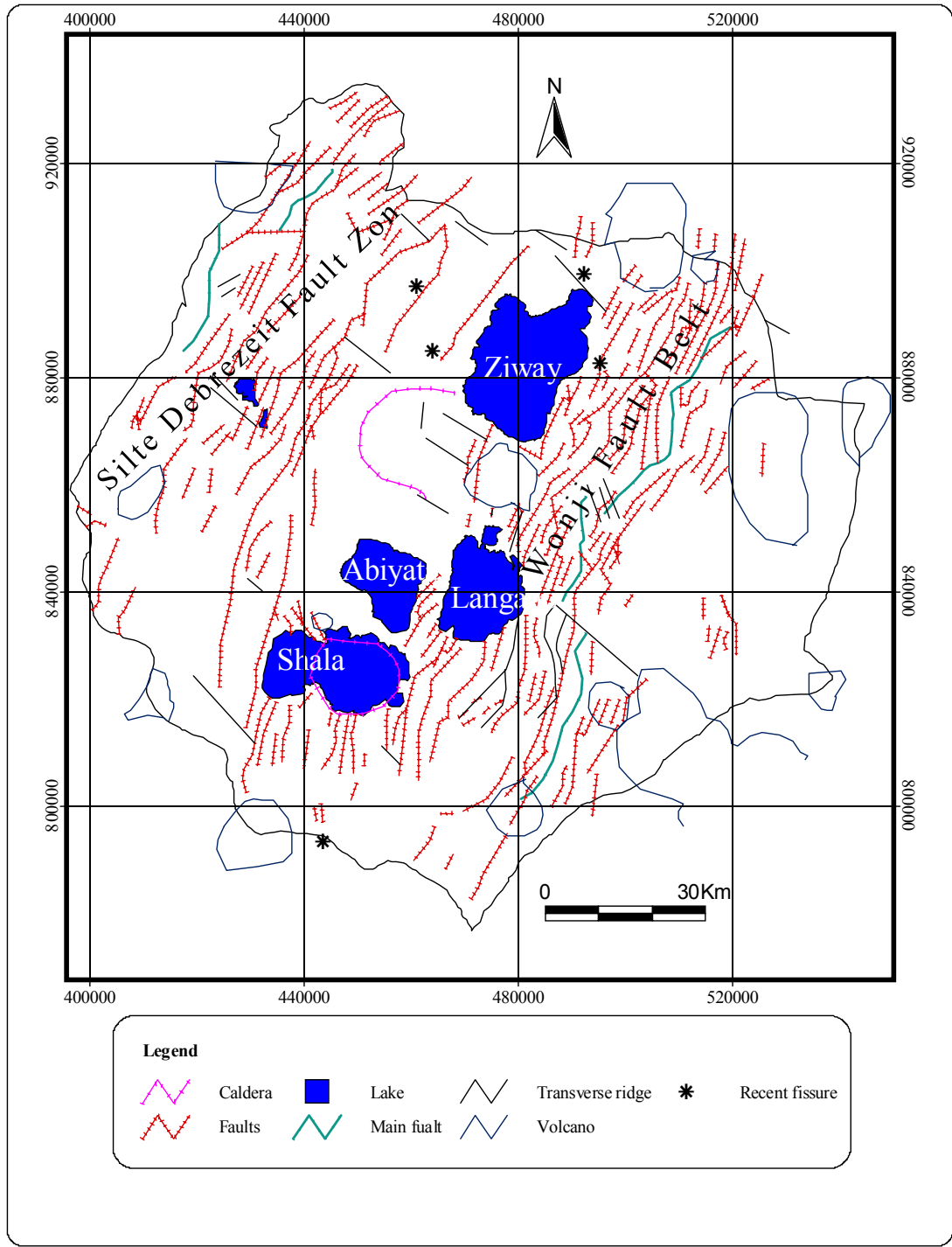


Figure 4 Lineament in the MER

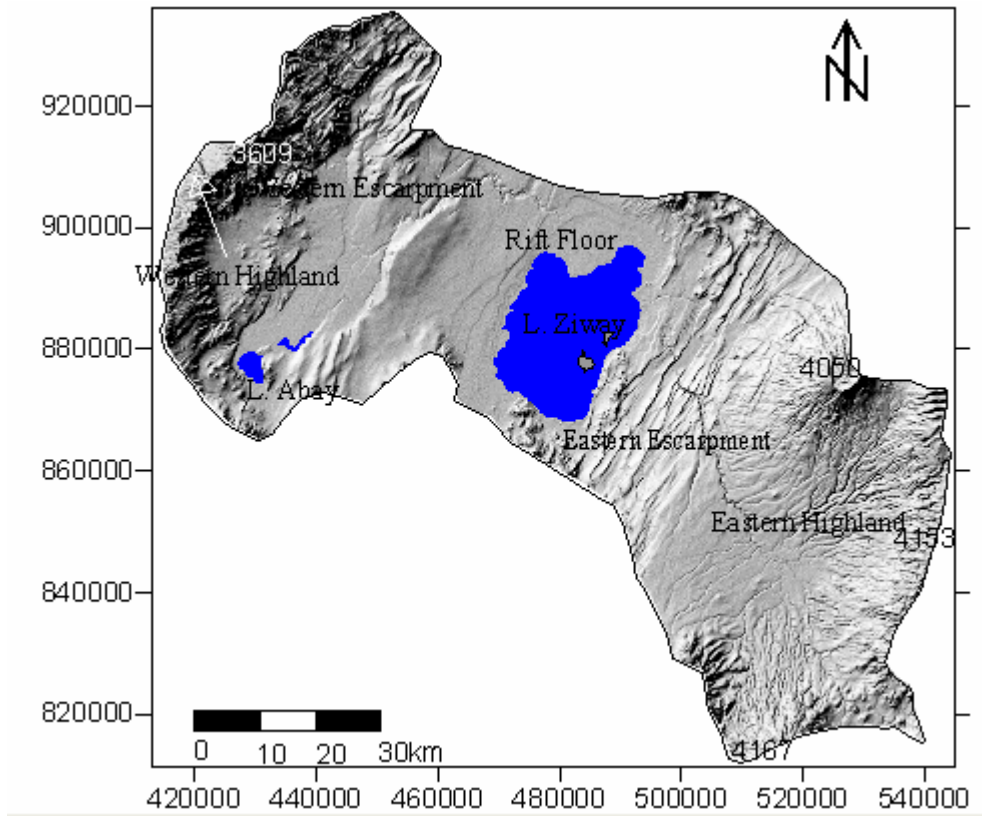


Figure 5 DEM of the Ziway area where detailed groundwater survey is carried out

## **GIS/Remote sensing**

During the second field trip (date), we took two MSc students of the GIS/Remote Sensing stream for site selection and preliminary data collection for their thesis work. The two students will be working in the following areas, which are related to the objectives of the MAWARI project:

1. Hawi Abate: hydrological modeling of the Meki catchment, which is one of the major catchment of Lake Ziway. She is doing land use / land cover mapping, change detection, and catchment-scale hydrological modeling using a distributed model (PRMS). With the same model, she will undertake some scenario analysis to see the impact of land use / land cover change on the hydrological regime, especially on the base flow to the lake ziway. She will also do climate change scenario analysis, which is very important from groundwater recharge point of view. She will also do land use mapping using Landsat ETM+ satellite images.
2. Binyam Tesfaw: He will be working on lineament analysis and thermal mapping using satellite images and GIS techniques. The main objective of his work would be to identify major hot spring manifestation areas, using thermal images of Landsat ETM+, which will have a big implication from groundwater study point of view. He will also make lineament maps and detailed lineament analysis using ArcGIS 9.1 and Visual Basic for Application to estimate lineament density, lineament intersection patterns lineament length analysis. The major expected output would be a correlation of lineament analysis results and the thermal maps with groundwater occurrence, distribution and flow patterns.

During the field visit, the two students together with their supervisor, Dr. Dagnachew Legesse, identified zoom-in sites where they will be focusing more on ground truthing after image analysis; they collected some ground truth data

for their image interpretation work in office, and did some preliminary mapping of the major geomorphological features. They did some preliminary image interpretation of their respective study areas before the field work and did some verification against the reality in the field. They also learned some basic skills of how to use hand-held GPS for field work, ground truth data collection, appreciation of the terrain, etc. Together with the other students involved in the project, the two students made some groundwater measurements and learned the basic skills of groundwater sampling. They will be doing more image analysis and modeling in office before they return for field checking again.

The two students are collecting data from various organizations pertinent to their study. This includes: meteorological data from National Meteorological Services Agency, topographic data from Ethiopian Mapping Authority, hydrological data from Ministry of Water Resources, geological data from Ethiopian geological Survey, and other relevant data from various sources. The analog data will be digitized and edited in the GIS laboratory of the Department of Earth Sciences under the supervision and guidance of Dr. Dagnachew Legesse. The satellite images will be georeferenced using the topographic maps as base maps. The image analysis will be accomplished under the guidance and supervision of their supervisor. A Visual Basic macro will be developed and used for the lineament analysis and thermal mapping project. For the hydrological modeling, a USGS made model called MMS-PRMS will be used in conjunction with ArcGIS 9 for data preparation and output presentations.

Geophysical survey is being carried out along four traverses over which gravity and magnetic measurements is to be taken. Due to the rugged topography along the selected traverse and the presence of volcanic centers, there is difficulty in continuous data acquisition, and hence the measurements are still on progress. One student is working in this field which is aimed to identify the continuity of geological structures along the northern boundary of the lakes region and Koka basin.

## Field pictures



Field team



team on discussion

Field



Awash river



Bore hole close to Awash river



Defluoridation plant at Langanu PA.



Eroded ash



Meki river-turbid



Land slide due to ground crack



Asphalt crack



Cattle drinking water at irrigation diversion



Pumping station from lake Ziway



level measuement

Water



Water level measurement



Discharge of waste water from rose farm



Fetching water from Bulbula river



Water level measurement



Weja river (Tributary of Meki river)



Filed discussion



Along Butajira road



Team in front of lake Ziway



Water level measurement



Water sampling



Wind pump



Gravity reading