Annex-5

Soft Component (Technical Assistance) Plan

Preparatory Survey
on
Rural Water Supply Project
in
Southern Djibouti

Soft Component Plan (Draft)

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Japanese International Cooperation Agency (JICA)
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1. Background of Soft-Components

1.1 Background and Outline of Project

(1) Outline of Project

The Republic of Djibouti (hereinafter referred to as Djibouti) has low annual precipitation of 150mm. The rainy season and areas where precipitation falls are not consistent, and the water supply is dependent on groundwater. In urban areas, 92% of the water is safe and clean. In rural areas however, only 54% of the water is safe for consumption. Therefore, people have to spend a lot of time and energy in order to fetch water for daily use in rural areas. In addition to the lack of rainfall, multiple droughts last year have resulted in a deep negative impact on the social-economic conditions resulting in increased poverty in Djibouti. Supplying safe and clean water is a significant problem closely related to basic education, healthcare, and rural development.

In Djibouti, a Poverty Reduction Strategy Paper (PRSP) and a National Social Development Plan（Initiative Nationale pour le Développement Sociale : INDS）have been developed. The Ministry of Agriculture, Livestock, Fishery, and Water supply (Ministère de l'Agriculture, de l'Élevage, de la : MAEM-RH) planned a Program of Food Security (Programme National de Sécurité Alimentaire : PNSA) based on the INDS. In "National Construction and Rehabilitation Programme for Deep Wells"which is shown in the PNSA, rural water supply development will be carried out in prioritized rural areas because of the lack of accessibility to drinking water. In the program, construction plans for 95 wells (with pump displacement of more than $30m^3/h$) were introduced to provide access to clean water for all people.

As part of that program, this Project consists of the construction of water supply facilities (boreholes, intake facilities, solar electric generation systems, and water tanks) and procurement of the necessary equipment for 9 sites in three southern districts (Dikhil, Ali-Sabieh, Arta) of Djibouti.

(2) Water Supply Service in Djibouti and the Situation in the Target Area

In Djibouti, water supply service is managed by the Water Department of MAEM-RH. This service includes studies, analysis, site selection, inspection of water intake facilities, regular monitoring, and O&M and are basically provided to people free of charge. However, realistically, it is difficult for the Water Department of the central government to manage the O&M of water intake facilities in rural areas. Therefore, the Water Department has adopted a policy that daily O&M, checks and repairs for water intake facilities are to be managed by a provincial branch of the Water Department or a Water Committee (WC) consisting of water users. A new section has been set up within the Water Department to organize the WC and sensitize them. However, the organization system of the Water Department is weak. It is difficult for them to provide efficient and effective water supply service because of a lack of human resources, equipment, budget, technique and capacity.

As mentioned above, water supply services are provided to the people free of charge by the

government. Therefore, the attitudes of “Benefit-received principle” or “performance of O&M by WC“ are not recognized as being important by residential people. As it is now, there is no practical example on performance of O&M by WC except in areas where residents have created a group and have managed to procure the necessary fuel for fetching groundwater for a part of a project area assisted by a donor/government. In addition, the target area of this Project is a nomadic compound. The men lead a nomadic existence with their livestock and women and elderly people stay in the community. Their life is “half-settlement and half-nomadic grazing”. There are various camps formed by a few nomadic households scattered distantly around the community for nomadic grazing. Each camp is managed by a chief, and a grand-chief manages various camps in the community. The structure, lifestyle, and social conditions of their community are different from regular communities. Therefore, they do not have enough opportunities for cooperative activity during their life in the community. Most water intake facilities that will be set up in this Project are far from their compounds. In addition, most people do not have experience on O&M for water intake facilities by group such as a WC because they often use shallow or traditional wells. Therefore, they need to be trained on the management of the O&M system for water intake facilities constructed by the Project.

(3) Situation of Water Resources Development and Management

The water resources section in the Water Department mainly operates groundwater development and applies electric surveys as groundwater resources finding method. The preparatory survey found the fact that two-dimensional electric survey is effective to realize the geological structure and estimate whether water is brine or not at groundwater survey in Djibouti. It is desirable to apply two-dimensional electric survey to improve the accuracy and efficiency of the future groundwater development.2 engineers participated to the preparatory survey and learned the method of two-dimensional electric survey. However, the preparatory survey team determined the location and lateral line of the electric survey, analyzed its result and determined the location of well excavation. Therefore two-dimensional electric survey has not been applied to water resources finding.

On the other hand, accumulation and evaluation of data such as data of well (geological structure, water quality and water level) is also necessary for improving accuracy of development. However, it is difficult to analyze the data comprehensively since the past result of electric survey and the record of well excavation have not been organized well.

(4) Challenges for Implementation of the Project

Based on the results of the preparatory survey, the main challenges and problems should be solved and improved for the implementation of the Project as follows:

(a) A specific management system for water intake facilities after construction does not exist in the Water Development Section. Systems for monitoring and repair and response have also not been implemented. Therefore, the Water Department cannot react to requests for repairs from people promptly.

(b) The management system for water resources in the Water Department is weak. There is a lack of staff who are familiar with specialized techniques such as survey/analysis technology for groundwater development/management and selection methods for drilling sites.

(c) The government supposed to provide construction of water intake facilities and O&M services after construction free of charge. The residents in the target area are not used to operating and maintaining these facilities by themselves through a WC.

(d) Residents in the target area are nomads and live in camps scattered throughout the community. Most water intake facilities are far from their camp. Therefore, it is difficult for the people to operate and maintain the facilities due to the communities' social and regional characteristics.

1.2 Necessity of Implementation of Soft Components

In accordance with the challenges and for implementation of this Project, the following two soft component areas need to be addressed: (1) Assistance for setting up an O&M system for water intake facilities by Water Department and the local people and (2) Capacity building for groundwater development and management.

(1) Assistance for Setting up an O&M System for Water Intake Facilities

Five water intake facilities for drinking and 4 water intake facilities for domestic use will be set up at 9 zones in the Project. For proper use and O&M of these facilities, a WC will be set up for 4 water intake facilities which will be expected users in the Project following the policies on rural water supply service in Djibouti.

"Department of Decentralization Promotion" has organized WC through the project which renovates the existing water supply (installation of solar electricity generator) by UNICEF, though it has not implemented any monitoring activity after the installation. However, because of above factors, the O&M system such as daily operation of facility, checking/management, collecting water user fees, etc. by WC (community people) will be reviewed of the existing method for set up of a WC in Djibouti. And then, its technical assistance will be needed to study and implement various methods for O&M in these communities.

(2) Capacity Building for Groundwater Development and Management

The main service of the water resource department in the Water Department is groundwater development. They use electric surveys to find potential groundwater resources. In the preparatory survey, a two-dimensional electric survey was found to be the most useful for understanding geologic structure and artificial presumption of salty water for the groundwater surveys in Djibouti. For future improvement of accuracy/efficiency, it is advisable to carry out two-dimensional electric surveys. Two engineers engaged in this preparatory survey and learned the measuring methods of the two-dimensional electric

survey. However, selection of the area for the electric survey, decisions on survey lines, analysis/interpretation of survey results, and decisions on drilling points for boreholes were done by the JICA Project team. If the local engineers can learn these methods, it will have a positive effect on capacity building for site selection for groundwater development. Also, it will lead to improving their success rate and reductions in cost for groundwater development.

On the other hand, it is important to keep updating, accumulating and evaluating data for improvement of borehole data (geology, water quality, water level), and geology. However, at present, earlier records of electric surveys and drilling have not been well organized. As a result, it is difficult to create comprehensive survey results of past and present data. Also, new implementation plans for groundwater surveys cannot be planned based on past data. Therefore, building up and improving the database is one of the major tasks that must be overcome.

2. Purpose of Soft Components

(1) Purpose of Soft Components

1) Assistance for setting up an O&M system for water intake facilities

To set up a WC (group or person in charge) and establish an operation system by community people overseen by the Water Department at 4 water intake facilities for drinking water .

2) Capacity Building for Groundwater Development and Management

To teach staff of the water resources section in the Water Department how to measure/analyze two-dimensional electric surveys and speculate on aquifer structure. In addition, they will be taught sustainable methods for survey plans and monitoring.

3. Output of Soft Components

The direct output of soft components in the Project is as follows:

1) Assistance for setting up an O&M system for water intake facilities

(a) O&M system for water intake facility run by community people will be arranged.
(b) WC (group or person in charge) of O&M at 4 water intake facility for drinking water will be set up in the target zone.
(c) A monitoring system and payment/maintenance system for water intake facility will be improved.

2) Capacity Building for Groundwater Development and Management

(a) Staff of the water resources section in the Water Department will learn methods of measurement, analysis, evaluation, and selection of drilling points using two-dimensional electric surveys.
(b) Staff of the water resources section in the Water Department will be able to create a plan for a two-dimensional electric survey and carry out monitoring.

4. Evaluation Methods of Effectiveness

Persons in charge of soft components will make a “Progress Report” and report their progress to MAEM-RH about one month after the commencement of activities. They will submit the Progress Report to the Project Manager. During the midterm of all soft components, the Project Manager will be given summarized Progress Reports for each activity and submit a “Progress Report on Soft Components (Technical Assistance) on the Progress of Activities” to JICA.

At the end of each activity, the person in charge of soft components will confirm and evaluate the effectiveness of training and assistance. They will make a “Final Report” and report their results to MAEM-RH. The Final Report will then be submitted to the Project Manager. The Project Manager will review the final reports of each activity and confirm and evaluate the effectiveness of the total soft component activities. In addition, the Project Manager will make a “Final Report on Soft Components (Technical Assistance) on the Completion of Activities” and submit it to MAEM-RH. The Project Manager will make a Japanese version of the “Final Report on Soft Components (Technical Assistance) on the Completion of Activities” and submit it to JICA. Since the target is nomad people who live in the scattered camps, it is concerned that the activities led by the people would be more difficult to continue than usual rural water supply. Additionally, on the aspect of groundwater development and capacity building, it is necessary to compare the survey result of groundwater development which was implemented with the grant equipments by Water Department and the result of well drilling and to confirm the cooperation between Water Department and local community etc. Total evaluator general evaluatee of soft-component will review the report submitted by each person in charge of soft-components and check the situation after soft-component activities. He will also evaluate the achievement of soft-component. After examining the result, Final Report of Soft-Component (Technical assistance) on the completion of Activities will be submitted to Government of Djibouti and Report of Soft-Component (written in Japanese) will be submitted to JICA with outputs, while the additional training will be conducted if necessary. Total evaluator of soft-component will be the project manager who is in charge of planning of groundwater development, O&M and can cover the evaluation and additional training of each soft-component.

The output and evaluation of the effectiveness of each assistance item are shown in Table 4-1:

Table 4-1 Evaluation Methods for Effectiveness of Soft Components

Technical Assistant Item	Activity Item	Direct Outputs (After completion of Soft components Activities)	Evaluation Item for Effectiveness	Measures of Evaluation
Assistance on setting up an O&M system for water intake facility	To review the existing O&M system of water supply, determine how to organize the WC	O&M system for water intake facility by community people will be arranged.	Establlishment of WC	To confirm the member of WC, activity items and contents of activity.

	(group or person in charge) and training/sensitization methods		Training manual, check manual	To confirm the presence of the manual documents and the result of the training and maintenance.
			O&M of the facility	To check the record of O&M.
	To set up a WC (group or person in charge) and provide training (sensitization) on O&M of water intake facilities in the target zone	WC (group or person in charge) for O&M of water intake facility will be set up in target zone.	WC	To confirm the member list and munites of meetings.
			Rule of water intake facility use	To check the abidance of rull
			Record of sanitation activities	To confirm the contents of activities and disperse.
			Collection of O&M expense etc	To check the users' name list and cashbook of water charge.
	To think about and try to manage a monitoring system of O&M conditions and repair/maintenance system in case of breakdown at the water intake facility	Monitoring system and payment/maintenance system for water intake facility will be improved.	Monitoring system and its implementation frequency	To check the monitoring report.
			How to handle the breakdown	To check the breakdown record.
			Format of repair request	To check the format.
Capacity Building for Groundwater Development and Management	Lecture on water resource electric survey and measuring practice on two-dimensional electric survey.	Staff of the water resources section in the Water Department will learn methods of water resources survey and analysis.	Engineers' capacity check (usage of equipment, storage or accumulation of measuring data, determination capacity of suitable areas for grouwnwater development and monitoring situation of existing boreholes, etc	To check the engineer's analysis and interpretation of the result of two-dimentional electric survey in actual borehole drilling.
	Analysis/interpretation of measuring data and management of water resources data	Staff of water resources section in the Water Department will be able to make survey plans for two-dimensional electric exploration and carry out	Storage of accumulation of measuring data	To confirm the latest situation of database establishment

		monitoring.	Determination capacity of suitable areas for groundwater development	To check the determining process and compare the process with the borehole drilling result.
			Monitoring situation of existing boreholes	To confirm the borehole registry

Source: JICA Study Team

5. Activities (Input Plan) of Soft Components

The contents of assistance activities of Soft Components are as follows:

1) Assistance in setting up an O&M system for water supply facilities
   (a) To review the O&M system of water supply, to determine how to organize the WC (group or person in charge) and how to train them.
   (b) To set up the WC (group or person in charge) and give training (sensitization) on O&M of 4 water intake facilities in the target zone.
   (c) To think about and try to manage a monitoring system of O&M conditions and a repair or maintenance system in case of breakdown at the water intake facility.

2) Capacity Building for Groundwater Development and Management
   (a) Lecture on water resource electric surveys
   (b) Measuring practice on two-dimensional electric surveys
   (c) Analysis or interpretation of measuring data and management of water resources data.

Details of these activities are shown in Tables 5-1(1) and (2). The Input Plan is shown in Table 5-2.

Table5-1 Detail Activity Contents (Plan)

(1) Assistance for setting up for O&M system of water supply facility

Activity Item	Activity Contents	Implementation Method	Output
1. To review the O&M system of water supply, to determine how to organize the WC (group or person in charge) and to introduce training/sensitization methods	1-1. To review the O&M system of the water supply facility and establish role sharing among related members.	To organize working team (Engineering construction section (person in charge of O&M), Regional branch office (person in charge of O&M), Management and assistance section for decentralization of water sector, Water resources section (persons in charge of monitoring)) To confirm existing O&M system by WC (residents) To review the monitoring system of water intake facility or WC (residents) and think about repairing the system in case of breakdown at the facility. To establish a coordination/communication system among the national government, regional office, and WC (residents), and determine the responsibility of each related member. To summarize a simple manual about the O&M system.	1. O&M system of water intake facility by community people will be arranged. 2. WC (group or person in charge) for O&M of water intake facility will be set up in target zone. 3. Monitoring system and payment or maintenance system for water intake facility will be improved.
	1-2. To organize the structure of the WC and sensitization/training agenda for residents.	□To determine the purpose, responsibility, and organizational process of WC (To review existing system or contents) □To arrange members of the WC and determine each member's responsibility. □To arrange training contents and methods for members of the WC who need technical training (hygiene education, operation and checking/repairing, etc). To consider other alternatives in case a WC cannot be set up (e.g. Using existing organizations or person in charge). □To summarize a simple manual on the responsibility of the WC and each member.	
2. To set up the WC (group or person in charge) and give training (sensitization) on O&M of water intake facility in target zone	2-1. To explain the O&M system of water intake facility to residents and to organize the WC and select members (Workshop in 4 target areas) *Sabllou will be managed by Water Development	□To explain the Project outline To explain O&M system of water intake facility by residents coordinated with government To explain responsibility, member composition, and main work contents. To select members of WC. *Methods of selection will be entrusted to each community To make and submit the members list of WC. To select one model site (Residents have a high willingness to participate and their construction will be completed in the early stages of the Project).	Input/Equipment 1.Japanese consultant （1 person） ・Person in charge of O&M ：3.9M/M 2.Car Sedan： 1car×25days? 4WD： 2 cars ×88days? 3.Assistance for sensitization activities (1 Person) 4. Assistance of training on hygiene & sanitation (e.g. Local NGO, UNICEF, etc.)
	2-2. To train members of WC members. (1 model area)	□ Work team explains each responsibility to members of WC in each community (e.g. WC management (chairman/vice chairman), O&M training (Person in charge of O&M), Hygiene Education (Person in charge of Hygiene & sanitation), User fee collection and management (Accountant)) To explain the repair system in case of outage at the facility to the person in charge of O&M.	
	2-3. Sanitization workshop on O&M (1 model area)	□To implement sensitization workshops/meetings for O&M of water intake facilities for residents 【User regulations/O&M cost etc…】 ・To explain about O&M of water intake facility and user regulations (rules). ・To discuss O&M cost (water fee, payment frequency, payment methods, collection/keeping user fees, etc). 【Hygiene Education】 ・To explain the necessity of a hygienic environment surrounding the water intake facility and cleaning up, etc. ・To sensitize residents about prevention of waterborne diseases (distribution of handouts, etc.) 【Operation/repayment/checking of water supply facility】 ・To explain about usage, consideration point / handling outages (daily usage, request system of repair, etc.) ・To explain about the responsibility of the water user association at outage (daily maintenance by residents).	
	2-4. To review activity in a model community and provide feedback to other areas	□To review training for members of WC and sensitization activities for residents. □To arrange challenges for implementation of activity in other areas and think of improvement methods and provide feedback on the activities.	
	2-5. To implement sensitization workshops in 3 target areas	□To explain about responsibility and details of activity to members of the WC in other areas based on revised activity contents in 2-4. □To implement sensitization workshops/meetings in other areas using the same method as the model area.	

3. To think about and try to manage a monitoring system of O&M conditions and a repair/maintenance system in case of breakdown at the water intake facility	3-1. To try a monitoring system for the water intake facility for WC including evaluation/renewal. (2 model areas)	□To implement monitoring on the O&M situation of the water intake facility using a monitoring system which will be made in 1-1 in two model areas. To try and test the repayment system from request of repairmen to recording of information at outage of water intake facility. □To review the results of □ and decide on an official monitoring system considering points that need improvement.	
	3-2. To try and evaluate monitoring systems in other target areas. (2 sites for monitoring and checking of situation of 5 sites)	□To carry out monitoring on the situation of the WC using the new method (□) at facilities where set up is completed in target areas. □To determine challenges and areas needing improvement based on monitoring results and summarized activity results. *Monitoring trial will be implemented shortly after construction of the water intake facility. After the Project, Djibouti government should implement the monitoring of facilities.	
Remarks：Work team is, It will be composed of members who are staff of sections related to O&M in the Water Department or Regional Branch office (e.g. Engineering construction division (person in charge of O&M), Branch office (person in charge of O&M), Management and assistance section for decentralization of water sector, Water resources section (persons in charge of monitoring)) and Japanese experts (about 8-10 members). The Japanese consultant will have a supporting role and promote execution of the work mainly by the working team. For hygiene education, we will ask UNICEF or the Ministry of Health to assist us.			

Source: JICA Study Team

(2)Capacity Building of Groundwater Development and Management

Activity Item	Activity Contents	Implementation Method	Output
1. Lecture on water resource electric survey and measuring practice on two-dimensional electric survey.	1-1.Lecture on water resource electric surveys	①Thinking about and discussing lecture contents and preparing the documents Creation of a draft of a database of water resources (spreadsheet) Introduction of technical aspects of groundwater surveys, axiom of electric exploration survey, and the relationship between special resistance and geological condition Introduction of methods of determining groundwater potential (Explanation of preparation survey) Selection of demonstration exploration survey points (5 points) Explanation on methodology of the two-dimensional survey (procured method)	1. Staff of the water resources section in the Water Department will learn methods of water resources survey and analysis. 2. Staff of water resources section in the Water Department will be able to make survey plan of two-dimensional electric exploration and carry out monitoring.
	1-2.Measuring practice on two-dimensional electric surveys	Selection of lateral line □Preparation work (Traverse line laying, checking settings of electric pole □Determination and evaluation of determination data Practice at 5 points (5 determination lines) Determination of correct or incorrect data	Input/Equipment 1. Japanese consultant (1 person) ・Training for groundwater development and management ：1.0M/M including document/report making and transportation) 2. Assistant (1person) : 0.9M/M 3.Car Sedan ：1 car×21 days 4WD ：2 cars×5 days
2. Analysis/interpretation of measuring data and management of water resources data	2-1.Analysis/interpretation of measuring data and management of water resources data	①Direction of analysis software (analysis method) ②Interpretation of analysis results and selection of borehole drilling points □Analysis/evaluation of existing water recourses database (abstraction of problems and explanations) □Thinking of ways of improving the existing water resources database and establishment of new database (Introduce database ideas) Thinking about management of the database and recording of survey data	
Remarks:			

Source: JICA Study Team

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Table 5-2 Detailed Input Plan

	Activity Item	Activity Contents	Implementation Method	Day	14	15	16	17	18	19	20	21	22	23
(Capacity Building on Groundwater Development and Management)	Moving	Tokyo(Narita)→Djibouti		2days										
	1. Lecture on water resource, electric survey and measuring practice on two-dimensional electric survey.	1-1.Lecture on water resource, electric surveys.	①Thinking about and discussing lecture contents and preparing the documents ②Creation of a draft of a database of water resources (spreadsheet) ③Introduction of technical aspects of groundwater surveys, review of electric exploration survey, and the relationship between special resistance and geological condition ④Introduction of methods of determining groundwater potential (Explanation of preparation survey) ⑤Selection of demonstration exploration survey points (5 points) ⑥Explanation on methodology of the two-dimensional survey (procured method)	9days										
		1-2.Measuring practice on two-dimensional electric surveys	①Selection of lateral line ②Preparation work (Traverse line laying, checking settings of electric pole ③Determination and evaluation of determination data (Practice at 5 points) (5 determination lines)	5days										
	2. Analysis/interpretation of measuring data and management of water resources data	2-1.Analysis/interpretation of measuring data and management of water resources data	①Direction of analysis software (analysis method) ②Interpretation of analysis results and selection of borehole drilling points ③Analysis/evaluation of existing water recourses database (detection of problems and evaluation) ④Thinking of ways of improving the existing water resources database and establishment of new database (database ideas) ⑤Thinking about management of the database and recording of survey data	6days										
	Reporting	Final activity report	*To submit as Progress Report of Soft Component	6days										
	Moving	Djibouti → Tokyo (Narita)		2days										
Assistance for setting up for O&M system of water supply facility	Moving	Tokyo(Narita)→Djibouti		2days										
	1.To review the O&M system of water supply, to determine how to organize the WC (group or person in charge) and to introduce training/sensitization methods	1-1.To review the O&M system of the water supply facility and establish rule sharing among related members.	①To organize working team (Engineering construction section (person in charge of O&M), Regional branch office (person in charge of O&M), Management and assistance section for decentralization of water sector, Water resources section (persons in charge of monitorings)) ②To confirm existing O&M system by WC (residents) ③To review the monitoring system of water intake facility to WC (residents) and think about repairing the system in case of breakdown of the facility. ④ To establish a coordination/communication system among the national government, regional office, and WC (residents), and determine the responsibility of each related member. ⑤To summarize a simple manual about the O&M system.	10days										
		1-2.To organize the structure of the WC and sensitization/training agenda for residents.	①To determine the purpose, responsibility, and organizational process of WC (To review existing system or contents). ②To arrange members of the WC and determine each member's responsibility. ③To arrange training contents and methods for members of the WC who need technical training (hygiene education, operation and checking/reporting, etc). ④To consider other alternatives in case a WC cannot be set up (e.g. Using existing organizations or person in charge). ⑤To summarize a simple manual on the responsibility of the WC and each member.	12days										
	2.To set up the WC (group or person in charge) and give training (sensitization) on O&M of water intake facility in target zone	2-1. To explain the O&M system of water intake facility to residents and to organize the WC and select members (Workshop in 4 target areas) *Sibiloo will be managed by Water Development	①To explain the Project outline. ②To explain O&M system of water intake facility by residents coordinated with government ③To explain responsibility, member composition, and main work contents ④To select members of WC. *Methods of selection will be entrusted to each community ⑤To make and submit the members list of WC. ⑥To select one model site (Residents have a high willingness to participate and their conservation will be completed in the early stages of the Project).	1 days										
		2-2. To train members of WC members (1 model area)	①Work team explains each responsibility to members of WC in each community (e.g. WC management (chairman/Vice chairman), O&M training (Person in charge of O&M), Hygiene Education (Person in charge of Hygiene & sanitation), User fee collection and management (Accountant).) ②To explain the repair system in case of outage at the facility to the person in charge of O&M.	5days										
		2-3. Sanitization workshop on O&M (1 model area)	①To implement sensitization workshops/meetings for O&M of water intake facilities for residents 【User regulations/O&M cost etc.】 ・To explain about O&M of water intake facility and user regulations (rules). ・To discuss O&M cost (water fee, payment frequency, payment methods, collection/keeping user fees, etc). 【Hygiene Education】 ・To explain the necessity of a hygienic environment surrounding the water intake facility and cleaning up, etc. ・To sensitize residents about prevention of waterborne diseases (distribution of mosquitos, etc.) 【Operation/repayment/checking of water supply facility】 ・To explain about usage, consideration point / handling cottages (daily usage, request system of repair, etc.) ・To explain about the responsibility of the water user association at outage (daily maintenance by residents).	4days										
		2-4. To review activity in model community and provide feedback to other areas	①To review training for members of WC and sensitization activities for residents ②To arrange challenges for implementation of activity in other areas and think of improvement methods and provide feedback on the activities.	2day										
		2-5. To implement sensitization workshops in other areas (3 target areas)	①To explain about responsibility and details of activity to members of the WC in other areas based on revised activity contents in 2-4. ②To implement sensitization workshop/meetings in other areas using the same method as the model area.	21days										
	Reporting	Progress activity report	*To submit as Progress Report of Soft Component	7days										
	Moving	Djibouti → Tokyo (Narita)		2days										
	Moving	Tokyo (Narita) → Djibouti		2days										
	3. To think about and try to manage a monitoring system of O&M conditions and/or repair/maintenance system in case of breakdown of the water intake facility	3-1. To try a monitoring system for the water intake facility for WC including evaluation/renewal. (3 model areas)	①To implement monitoring on the O&M situation of the water intake facility using a monitoring system which will be made in 1-1 in two model areas. To try and test the repayment system from request of repairman to recording of information at outage of water intake facility. ②To review the results of ① and decide on an effective monitoring system (considering points) that need improvement.	7days										
		3-2. To try and evaluate monitoring systems in other target areas.	③To carry out monitoring on the situation of the WC using the new method (②) at facilities where set up is completed in target areas (4 communities). ④To determine challenges and areas needing improvement based on monitoring results and summarize activity results. *Monitoring trial will be implemented shortly after construction of the water intake facility. After the Project, Djibouti government should implement the monitoring of facilities.	25days										
	Reporting	Final activity report	*To submit as Final report on Soft Component.	7days										
	Moving	Djibouti → Tokyo (Narita)		2days										
(Additional)	Moving	Tokyo (Narita) → Djibouti		2days										
	To confirm of effectiveness of Soft Component		To evaluate of technical assistance for "Capacity Building of Groundwater Development and Management" and "Assistance for setting up for O&M system of water-supply facility"	12days										
	Reporting	Final activity report	*To submit as Final report on Soft Component.	7days										
	Moving	Djibouti → Tokyo (Narita)		2days										

Source: JICA Study Team

6. Procurement Methods of Implementation Resources for Soft Components

Assistance items and procurement methods of implementation resources for soft components in this Project are as follows:

Table 6-1 Assistance Items and Procurement Methods of Implementation Resources for Soft Components

Technical Assistance Item	Activity Item	Implementation Pattern	Procurement Method of Implementation Recourses
(1)Assistance for setting up an O&M system for water intake facility	To review the O&M system of water supply, to determine how to organize the WC (group or person in charge) and to introduce training/sensitization methods.	Direct Assistance	Direct assistance by Japanese consultant
	To set up the WC (group or person in charge) and give training (sensitization) on O&M of water intake facility in target zone		
	To think about and try to manage a monitoring system of O&M conditions and a repair/maintenance system in case of breakdown at the water intake facility		
(2)Capacity building for groundwater development and management	Lecture on water resource electric surveys	Direct Assistance by Japanese consultant	Direct assistance by Japanese consultant
	Measuring practice on two-dimensional electric surveys		
	Analysis/interpretation of measuring data and management of water resources data		

Regarding “Assistance for setting up an O&M system of water intake facility”, along the lines of the strategy for rural water supply service in Djibouti, a WC (group or person in charge) will be set up and trained to create an O&M system that will be run by community person under the jurisdiction of the Water Department of MAEM-RH. In addition, a monitoring system will be implemented preceding construction of the facility. A Japanese consultant will assist the staff of the section for decentralization of water sectors and other related sections related to monitoring or O&M. Regarding assistance for “Capacity building for groundwater development and management”, the Japanese consultant will carry out training for staff of the water resource developing section at the time of procurement of equipment. The utilization of new electric exploration equipment, analysis methods of survey results, interpretive procedures, etc., will be taught to them for future water resource development. Also, instruction on well databases and recording systems for water resources data for monitoring of water intake facilities will also be given.

7. Implementation Schedule of Soft Components

Regarding assistance for “Setting up an O&M system for water intake facilities”, after reviewing methods of establishment and training of the WC, preceding construction of the water intake facility, activities for organizing the WC and training the members on the O&M of the facility, sanitation and

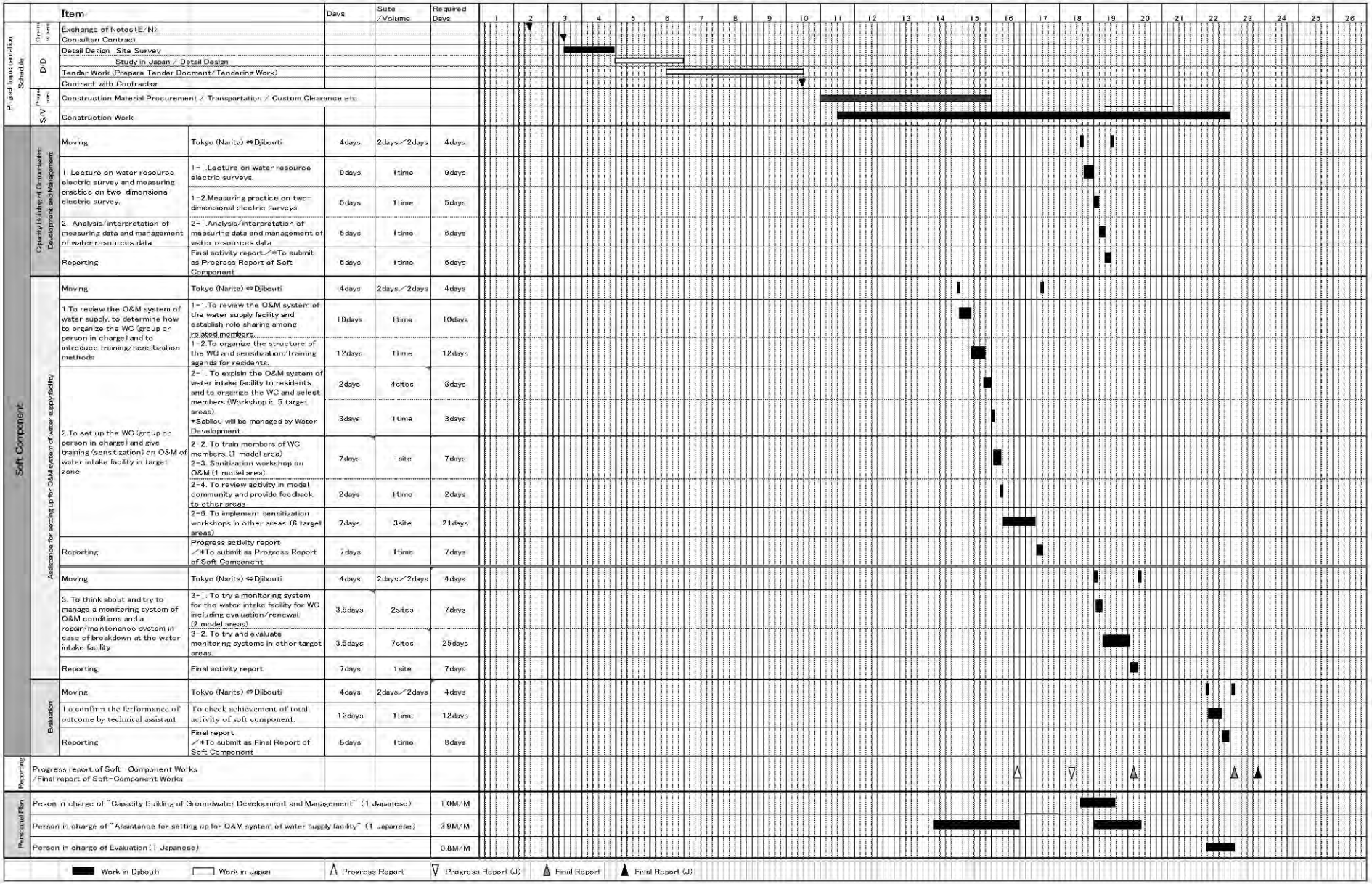
hygiene education, etc. will be carried out for about 2.5 months. A few months later, trials and re-arrangement of monitoring and repair systems of the facility will be carried out for about 1.4 months.

For “Capacity building for groundwater development and management”, lectures and practice on measurement/analysis will be carried out for capacity building of staff in the water resources section. Additionally, data arrangement/management will be taught for monitoring wells after construction facilities are finished. The total time required will be about 1 month.

In addition, the Project Manager (PM) will evaluate all the soft components for about one month at the end of activity. Then, the PM will give suggestions on future activity in Djibouti.

The implementation schedule of soft components is shown in Table 7-1.

Table 7-1 Schedule of Implementation



8. Output (Deliverables) of Soft Components

Output (Deliverables) of soft components is as follows:

Table 8-1 Output (Deliverables) of Soft Components

Deliverables/Documents		
Report Title		Related documents/Output
Djibouti side	Japanese side	
Progress Report (F)	Progress Report (J) of Soft components （Including of Progress Report (F)	1) Assistance for setting up an O&M system for water intake facilities Progress report of activities and related documents ・ Name list of WC (members, person in charge) ・ Rules/regulations of O&M at each site ・ Other related documents 2) Capacity building for groundwater development/management Training contents and their results and evaluation ・Summary of Lectures ・Analysis of data and results Borehole management data, etc.
Final Report (F)	Final Report (J) on Soft Components (Including of the Final Report)	1) Assistance for setting up an O&M system for water intake facilities Achievement/evaluation of output at the end of activity ・ O&M system on the initiative of residents (organization, manual on training methods) ・ Operation and checking/repair manual for water supply facility ・ Monitoring sheet, format for request of repairs and utilization manual. 3) Project Manager (total evaluation) will summarize Final report of total activity based on progress report and final report.

Source: JICA Study Team

Note: J=Japanese, F=Frence

9. Estimation Cost for Implementation of Soft Components

Operation costs of soft components are shown in Table 9-1.

Table 9-1 Expense account

NO.		US Dollar		Local Currency		Japanese Yen (1,000 yen)	Total (1,000 Yen)
		US$	Yen Equivalent (1,000 yen)	DJF	Yen Equivalent (1,000 yen)		
1	Employment Cost					6,364	6,364
2	Direct Expense	16,800	1,541	5,779,865	3,005	6,961	11,507
3	Overhead Cost					8,145	8,145
	Total	16,800	1,541	5,779,865	3,005	21,470	26,016

Source: JICA Study Team

Note) 1US$=91.74 Yen, 1DJF=0. 1 52 Yen (2010. May)

10. Responsibility of Implementation Agency in Djibouti

In order to achieve success of these soft components, it will be a basic premise that the Water Department, which has been created for this purpose by the Djibouti government, has to secure the required budget and use the money properly for this Project. Also, staff of the Water Department will engage in the activities of this Project and their water intake service with consciousness of, "they should provide water supply service to people" as public officers. Based on this, technology, knowledge and techniques, which will be learned through the soft component activities, should continuously be used in their daily work. The target area of this Project is a nomadic settlement. It consists of community figures and local community structure different than a regular community. Most community people (users) live in scattered camps at a distance from the water intake facility. Therefore, a opportunity for cooperative activities among people or camps is limited. Their willingness to assist with O&M in collaboration with community members is low. To ensure the success of this Project, the government agencies in Djibouti must continue to carry out their responsibility of monitoring/managing the O&M situation, confirming theft or breakage, and assisting the WC (group/person) in charge of the water intake facility that have been constructed. They must also assist in sustaining self-help by community people (users of the water intake facility).

In addition, one water intake facility for drinking which will not bank on user will be managed by Water Department in this project. Also Japanese government decided to set up water intake facility to 4 test boreholes which have some water quality problem for domestic/miscellaneous use under the managing by Water Department based on strong request from Djibouti government because of lacking water level. Water of these facilities stray of water quality standard of WHO and might influence of health problem. Therefore, sensitization/complete control of user/facility will be complete required

Continued efforts of the implementation agency and community people, their operability, disincentives, and necessary measures after soft components activities are as follows:

Continued efforts	Operability	Disincentives	Necessary measures
Staff of the Water Department will utilize know-how of electric exploration survey or analysis for water resources development and monitoring/management work after learning.	Implementation is possible under proper conditions.	・ Existence or nonexistence/changing of budgetary steps ・ Considerable decline of staff, change in personnel of staff who received training ・ Property loss / breakdown of equipment.	・ Secure the budget for activity by Djibouti government (Water Department) ・ Sustainable assignment of person in charge of water agency in Djibouti (Water Department)
Staff of the Water Department will utilize O&M system done by community people (WC) and assistance/management work on the system by the Water Department	Implementation is possible under proper conditions.	・ Existence or nonexistence/changing of budgetary steps ・ Assistance from district cannot be received ・ Community (people) cannot be rerate related	・ Management of water intake facility using borehole recorder (by water resource section) ・ Making & checking of monitoring sheet and format (for reporting by WC), regular visits to community by Water Department representatives.
Sustainable O&M will be managed water intake facility of drinking water by community People (WC) in target area.	Situation is quite different in each area. Implementation is possible under proper conditions.	・ Water Department/Regional office can not assist community due to lack of budget, technical capacity, personnel) ・ Community will disappear (Residents will move to	・ WC should submit report using monitoring sheet to the Water Department regularly. ・ Regular monitoring will be implemented (min. 1time/year) and a budget will be secured for the

		other areas) ・ Water point will dry up	activities.
Water intake facilities of drinking water which set up in the Project will be monitored regularly using new monitoring methods.	Implementation is possible under proper conditions.	・ Existence or nonexistence/changing of budgetary steps ・ Considerable decline in staff, change in personnel of staff who received training ・ WC (residents) will not cooperate ・ Problem with access or transportation to community	・ WC should submit report using monitoring sheet to the Water Department regularly. ・ Regular monitoring will be implemented (min. 1time/year) and a budget will be secured for the activities.

In addition, obligatory costs for the Djibouti government for soft components are shown in Table 10-1.

Table 10-1 Necessary Costs for Implementation of Soft Components

Exchange Rate: 1DJF =0.51 JPY

	Defrayer in Djibouti	Djibouti Fran 1,000 DJF	Japanese Yen (1,000 JPY)
Travel expenses of C/P	MAEM-RH	5,076	2,589
Total		5,076	2,589

Note) This calculation assumes that 8 people will take part in the activity of “Setting up an O&M system for water intake facility” for 68 days and 4 people will take part in “Capacity building for groundwater development and management” for 20 days.

Annex-6

List of Collected Documents

List of Collected Data

		Project ID		Survey Team No.			
Region	Africa	Project Name	Preparatory Survey on Rural Water Supply Project in Southern Djibouti	Type of Survey	Development Survey	Responsible Depertment	Global Environment Depertment Water Resources and Disaster Management Group Water Resources Management Division II
Country	Republic of Djibouti	Name of Assigned Institution		Survey Period	January 2010 - March 2011	Name of Personnel	Takeharu KOJIMA

No.	Title	Form (book, video, map, photo etc)	Original/Copy	Publisher	Date of Publication
1	Activités des Centres Santé Communautaire	Word	Original	N/A	N/A
2	Caractere Microbiologique et Phico-chimique de l'Eau de Boisson	PDF	Copy	N/A	N/A
3	Tableaux des Valeurs Guides	Word	Copy	N/A	N/A
4	Résultats de la campagne de forages de reconnaissance effectuée dans la Plaine de Hanlé	PDF	Original	Ministère Fédéral de la Coopération Economique et du Développment	1999
5	Rapports D'Etudes Geophysiques	PDF	Original	N/A	N/A
6	Schema Directeur National De l'Eau	PDF	Copy	Secretariat Technique de l'Eau	2000
7	Republic of Djbouti Development Plan for Primary Sector 2010 - 2020	PDF	Original	Turkish Development and Cooperation Agency	N/A
8	Réhabilitation AEP de Villages Ruraux	PCF	Original	UNICEF/Bureau d'Alger	N/A
9	Profile de la Pauvreté à Djibouti	PDF	Original	République de Djibouti / Nations Unies	2002
10	Rapport Final	PDF	Original	Enquete Djiboutienne A Indicdateurs Multiple (EDIM)	2007
11	Etat d'Inventaire Forages du 31/12/2008	PDF	Copy	Office National de l'Eau et de l'Assainissement de Djibouti (ONEAD)	2008
12	Journal Officiel de la République de Djibouti	PDF	Copy	République de Djibouti	2006
13	Convention Collective	PDF	Copy	N/A	1976
14	Water Demand Forecast	PDF	Copy	N/A	N/A
15	Water Resources of Dikhil	PDF	Copy	N/A	N/A
16	Etat des Lieux de l'Utilization de l'Eau dans le District de Dikhil	PDF	Original	République de Djibouti	N/A
17	Eléments de Réflexion sur le Role et la Fonction de Diffé rents Intervenants Nationaux de la Gestion et l'Exploitation de la Resources en Eau	PDF	Copy	République de Djibouti	N/A
18	Journal Officiel de la République de Djibouti (Minitere de l'Interieur et de la Decentralization)	PDF	Copy	République de Djibouti	2004
19	Physical and Chemical Factors (handwriting)	PDF	Copy	N/A	N/A
20	Rapport de Forage (Alimentaiton en Eau Potable des Zones Rurales de la République de Djibouti)	PDF	Copy	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, République de Djibouti	2005
21	Norme des Eaux Oitabke eb Région Aride Selon Schoeller	PDF	Copy	GERD, Département d'Hydrochemic	2002
22	Tarifs en Vigueurs a Compter du 24 Janvier 2010	PDF	Copy	N/A	2010
23	Rapport Final (Alimentaiton en Eau Potable des Zones Rurales de la République de Djibouti)	PDF	Copy	Institut Superieur et de Recherches Scientifiques et Techniques (ISERST)	1998

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Country	Republic of Djibouti	Name of Assigned Institution		Survey Period	January 2010 - March 2011	Name of Personnel	Takeharu KOJIMA

No.	Title	Form (book, video, map, photo etc)	Original/Copy	Publisher	Date of Publication
24	Report on Geophysical Surveys for Barehole Site Investigation in Djibouti	PDF	Copy	Global Engineering Consultant	2008
25	Tableau Récapitulatif des Points d'Eau Ali-Sabieh	Excel	Copy	N/A	N/A
26	Catalogue Forage_arta_Djibouti	Excel	Copy	N/A	N/A
27	Tableau Récapitulatif _dikh_fin_Carte	Excel	Copy	N/A	N/A
28	Model de Convention de Partenariat	Word	Original	French Red-Cross	N/A
29	Questionnaire évaluation communauté Projec AFD	Word	Original	French Red-Cross	N/A
30	Annuaire Statistique 2008 - 2009	PDF	Original	Ministere de l'Education Nationale et de l'Ensignement Superieur	2009
31	Salles Construites en 2007	Excel	Original	N/A	N/A
32	Selection Hanlé	PDF	Copy	Dr. Gamal	N/A
33	Schema Directeur Ville Interieur	PDF	Copy	Secretariat Technique de l'Eau	1999
34	Station de Dikhil	Word	Original	N/A	N/A
35	Pluviométrie Mensuelle én mm	Word	Original	N/A	N/A
36	Temperatures Mesurées en Republique de Djibouti	Word	Original	N/A	N/A
37	Géologie de la République de Djibouti（Map of Djidouti)	Map (JPEG)	Copy	N/A	N/A
38	Précipitations Mayennes Annuelles	JPEG	Copy	N/A	N/A
39	Etat de la Situation Hydraulique de la Region de Dikhil Forage - Retenues	PDF	Copy	Direction de l'Eau - Service des Ressources en Eau MAEM - RH	2007
40	Etat de la Situation Hydraulique de la Region de Dikhil Puits Communautaires - Sources	JPEG	Copy	Direction de l'Eau - Service des Ressources en Eau MAEM - RH	2007
41	8 Regions of Djibouti (Map)	PPT	Original	Direction de l'Eau - Service des Ressources en Eau MAEM - RH	2008
42	Statistic by DISED	PDF	Copy	DISED	2002/2003
43	Direction de l'Eau	PDF	Copy	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, République de Djibouti	N/A
44	Etat de Lieux de la Situation Hydraulique District D'Ali-Sabieh	PDF	Copy	UNICEF	2006/2007
45	Rapport de Mission Portant Sur l'Evaluation de l'Impact des Secheresses	PDF	Copy	Ministere de l'Interieur et de la Decentralization	2008
46	JCS Application form	PDF	Copy	N/A	N/A

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No.	Title	Form (book, video, map, photo etc)	Original/Copy	Publisher	Date of Publication
47	Water quality standard and price of examination	PDF	Copy	N/A	N/A
48	Construction list (Saudi Arabia)	PDF	Copy	N/A	2009
49	Dernier_Organigramme	PDF	Original	N/A	2009
50	Rapport de Mission <<Etat de Lieu du Réseau d'Observation Hydro Climatologie	PDF	Original	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, République de Djibouti	2008
51	Pluviométrie Mensuelle én République de Djibouti	PDF	Original	N/A	N/A
52	Tableau Recapitulatif des Points d'Eau Analysés dans la Région de Dikhil	PDF	Original	N/A	N/A
53	Tableau Recapitulatif des Points d'Eau Analysés dans la Région de Dikhil	PDF	Copy	Meteorological Department	2008
54	Rapport de Forage (Alimentaiton en Eau Potable des Zones Rurales de la République de Djibouti) BALADLOU	PDF	Copy	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, République de Djibouti	2005
55	Rapport de Forage (Alimentation en Eau Potable des Zones Rurales de la République de Djibouti) DAY	PDF	Copy	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, République de Djibouti	2006
56	Rapport de Forage (Alimentation en Eau Potable des Zones Rurales de la République de Djibouti) ILLYSSOLA	PDF	Copy	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, République de Djibouti	2006
57	Rapport de Forage (Alimentation en Eau Potable des Zones Rurales de la République de Djibouti) WADDI	PDF	Copy	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, République de Djibouti	2006
58	Rapport d'Energie Solaire en République de Djibouti	PDF	Copy	N/A	N/A
59	Carte de la Geologie Simplifiee de la République de Djibouti	JPEG	Copy	N/A	N/A
60	Carte Geologique de la République de Djibouti DIKHIL	JPEG	Copy	N/A	N/A
61	L'Hydraulique Rural en République de Djibouti	Word	Copy	UNICEF/Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques	2007
62	Carte Ecole (Location of elementary school)	JPEG	Original	N/A	2009
63	Inventaire du Patrimoine Bati du Menesup	Excel	Original	N/A	N/A
64	Plan d'Action 2010/2011	Word	Original	Ministere de l'Agriculture, de l'Elevage et de la Mer, Charge de Ressources Hydrauliques, FAO	2009
65	National Program of Food Security (NPFS) and Action Plan in the Primary Sector Summary of the Program	Word	Original	N/A	N/A
66	Plan d'Action(Action plan of water resources department to UNICEF)	Excel	Original	N/A	N/A
67	Utah_Drinking Water Standards	PDF	Original	N/A	N/A
68	Council Directive 98/83/EC of November 1998 on the quality of water intended for human consumption	PDF	Original	European Committee	1998
69	Statistiques du Budget National pour la Direction de l'Eau Previsons 2005 - 2009	Excel	Original	N/A	2010

List of Collected Data

		Project ID		Survey Team No.			
Region	Africa	Project Name	Preparatory Survey on Rural Water Supply Project in Southern Djibouti	Type of Survey	Development Survey	Responsible Depertment	Global Environment Depertment Water Resources and Disaster Management Group Water Resources Management Division II
Country	Republic of Djibouti	Name of Assigned Institution		Survey Period	January 2010 - March 2011	Name of Personnel	Takeharu KOJIMA

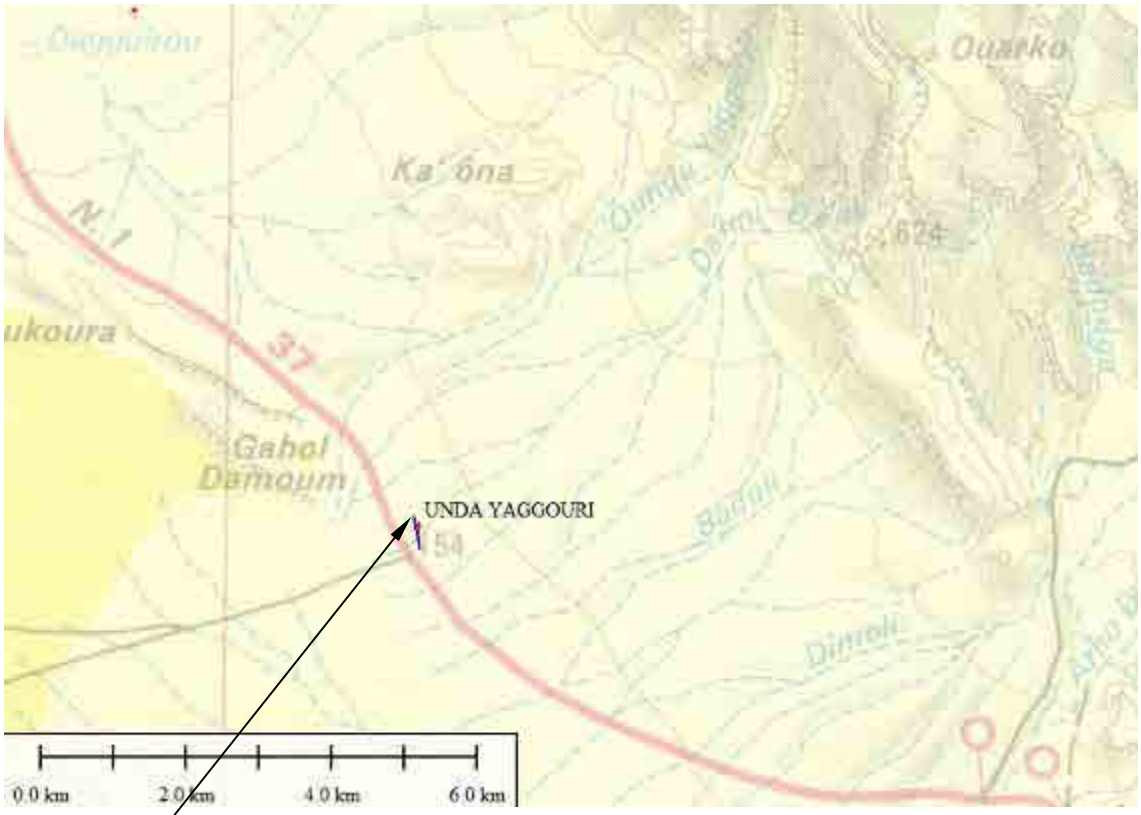
No.	Title	Form (book, video, map, photo etc)	Original/Copy	Publisher	Date of Publication
70	Public Investment Program（English)	Excel	Original	N/A	2009
71	Public Investment Program（French)	Excel	Original	N/A	2009
72	Poverty Reduction Strategy Paper Interim Report	Excel	Original	Republic of Djibouti	2001

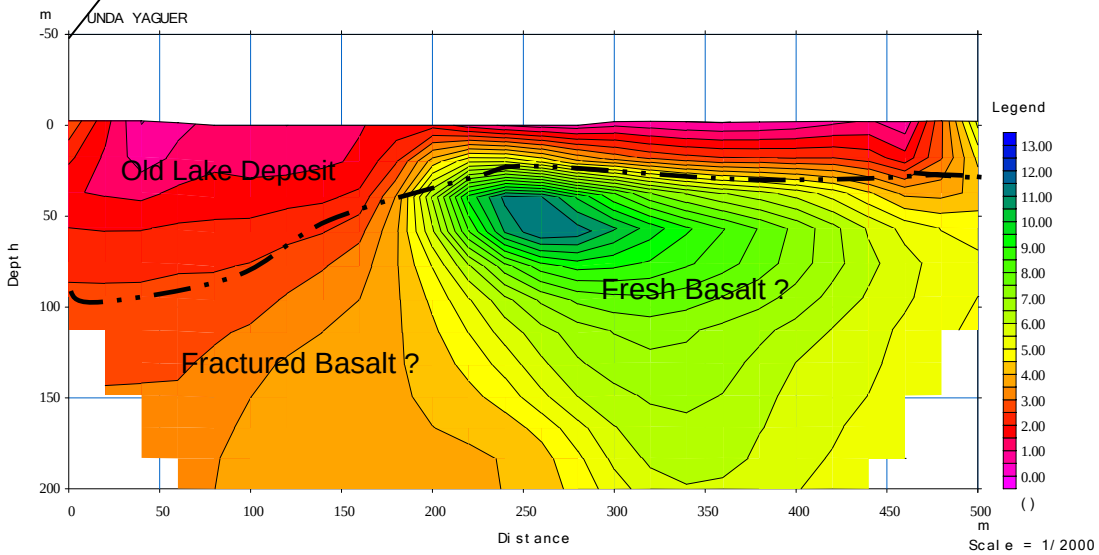
Annex-7

Geophysical Survey

(1) HANLE (UNDA YAGGOURI)

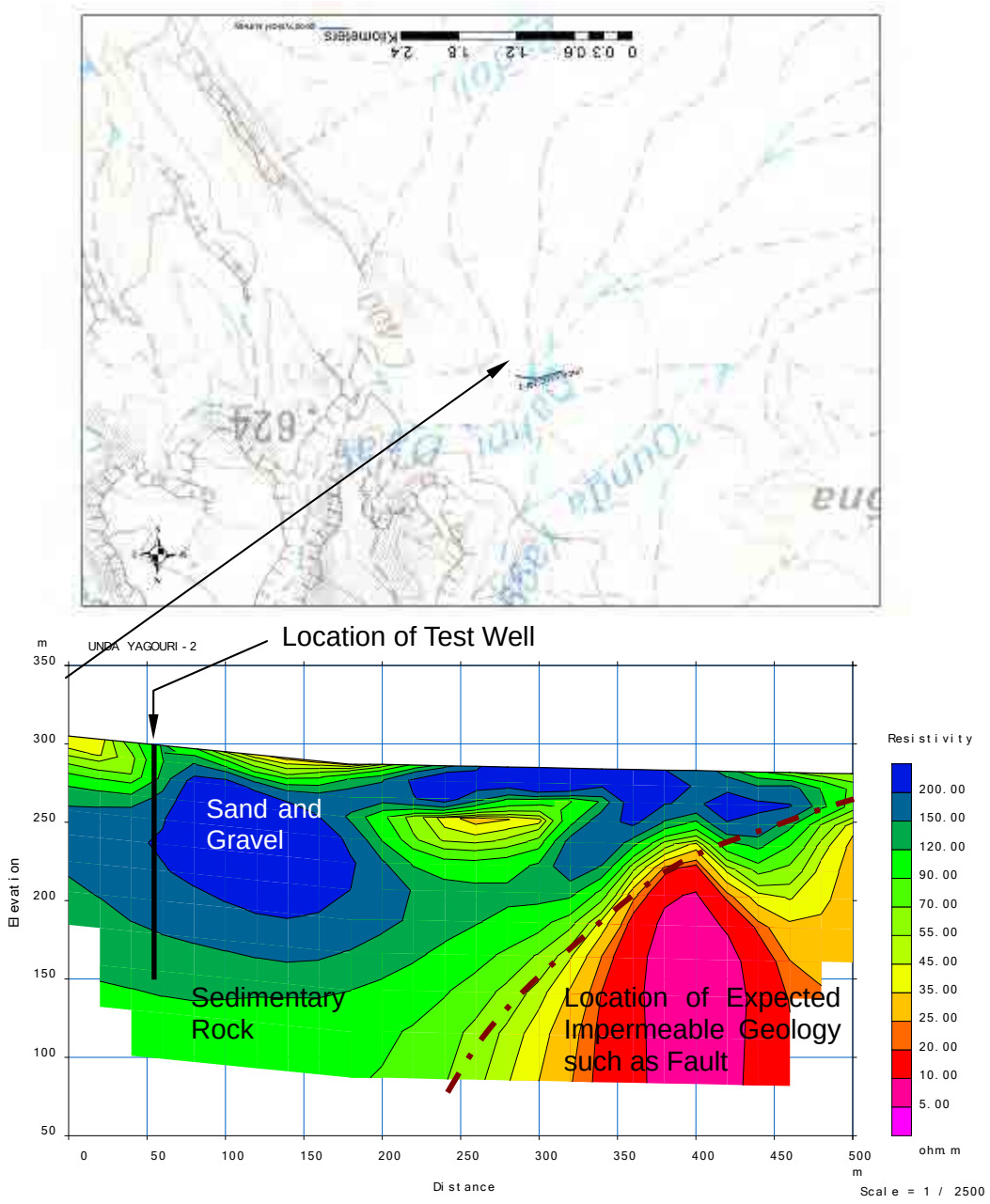
The measurement position is located on national road No.1 between Yoboki and Galafi. It is not suitable for water development because old sediment is widely distributed and high salt accumulation is anticipated.
Results of the profiling also show the distribution of a low resistivity area of less than 13 Ω･m and a possibility of saline water.





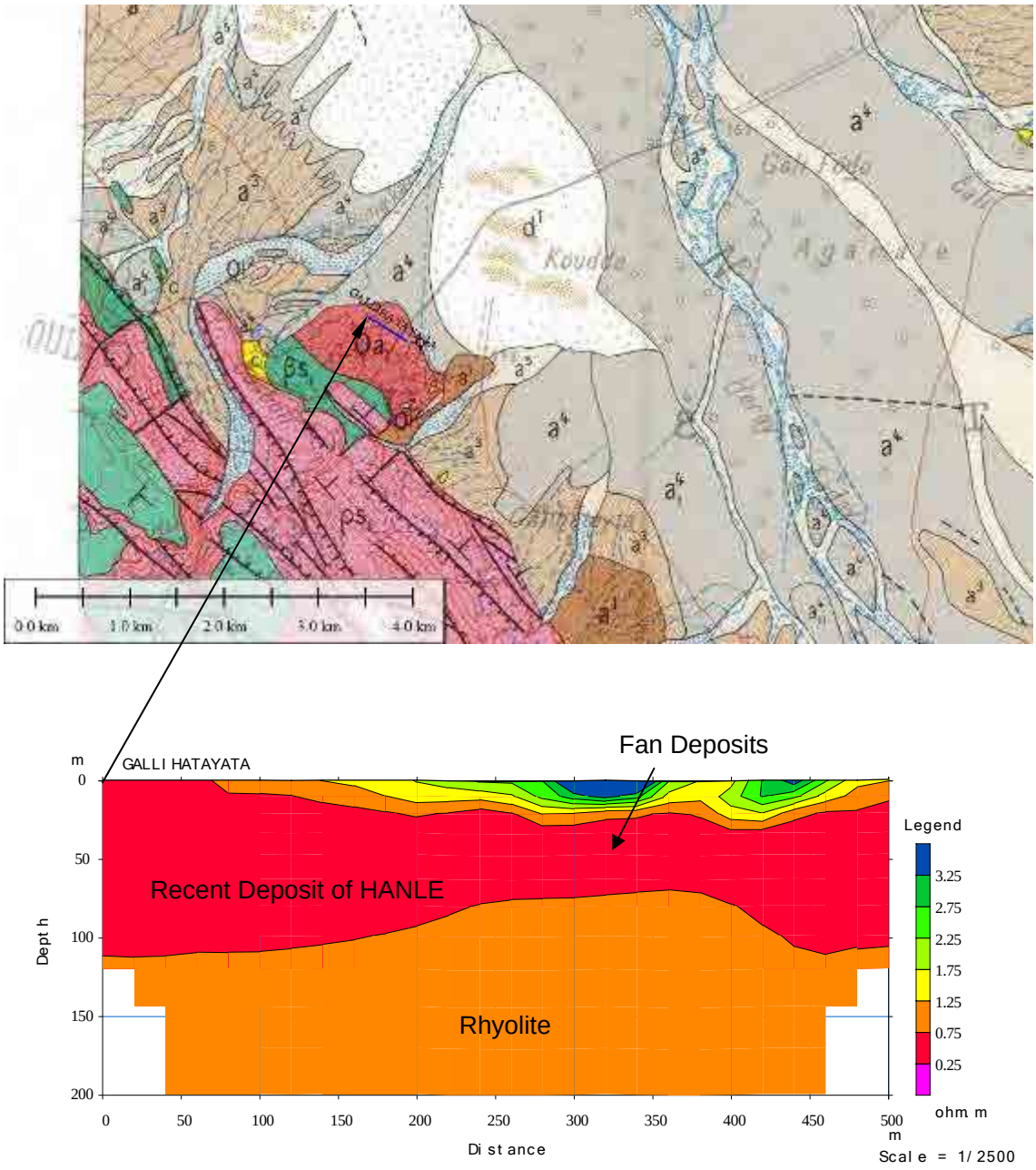
(2) HANLE (UNDA YAGGOURI (2))

There is a catchment area in the mountain, but the groundwater is assumed to be at a depth greater than 200 m. The possibility of perched water along wadi was examined. Potential areas have been located on the west side of the profile line where an impermeable layer is distributed in the lower part of the area and perched water might be formed. (Since mobilization of a drilling rig to the location was impossible, reluctantly, a well was drilled at the 60 m point of the profile line. The well failed due to the difficulty to sustain the perched water.)



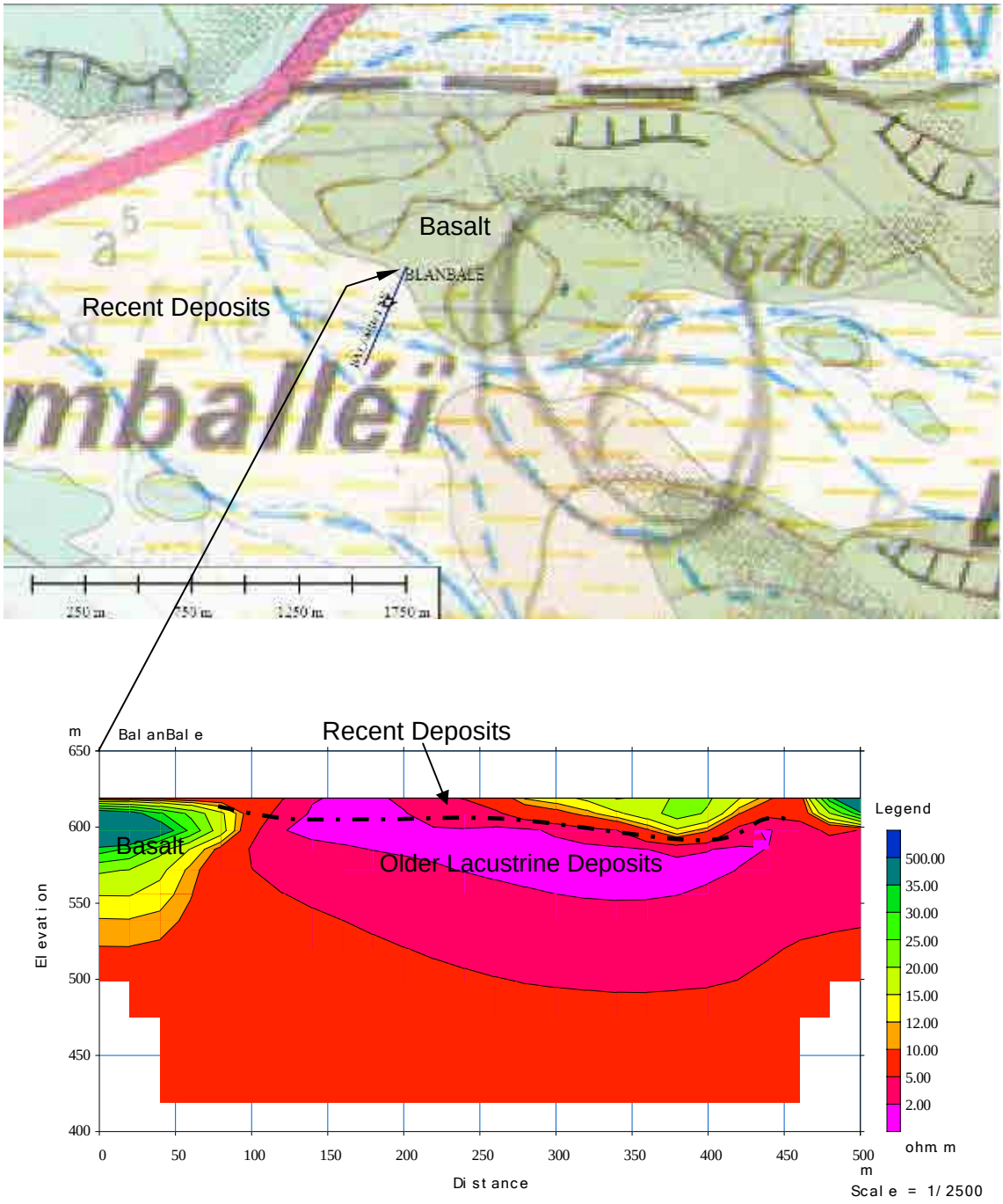
(5) GAALI HATAYATA

The measurement position is on the downstream side of Hanle Wadi. Generally, salt is accumulated at the downstream of big wadis and saline water is anticipated. Water retrieved from other wells in the vicinity by other projects shows high salt content and is not used for drinking. In these cases, water development is aimed at fan deposits on the west side of the skirts. However, the thickness of the deposit is not sufficient and resistivity of the deposit is less than 2 Ω･m; therefore, only water with a high salt content is expected.



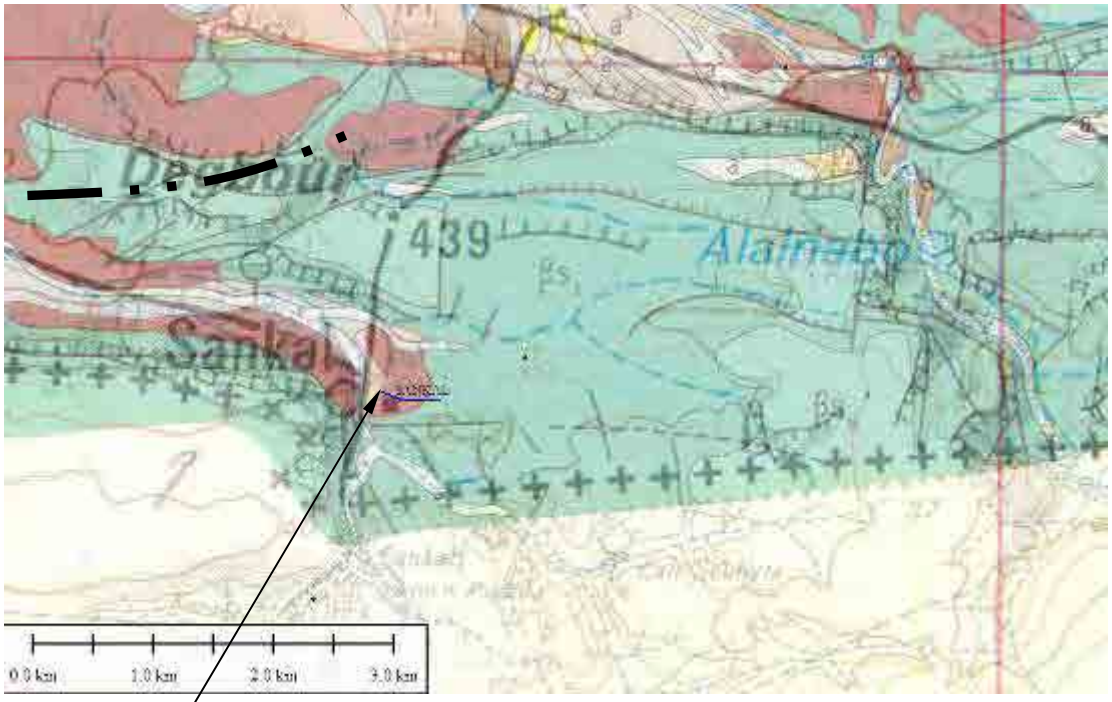
(6) BLANBALE

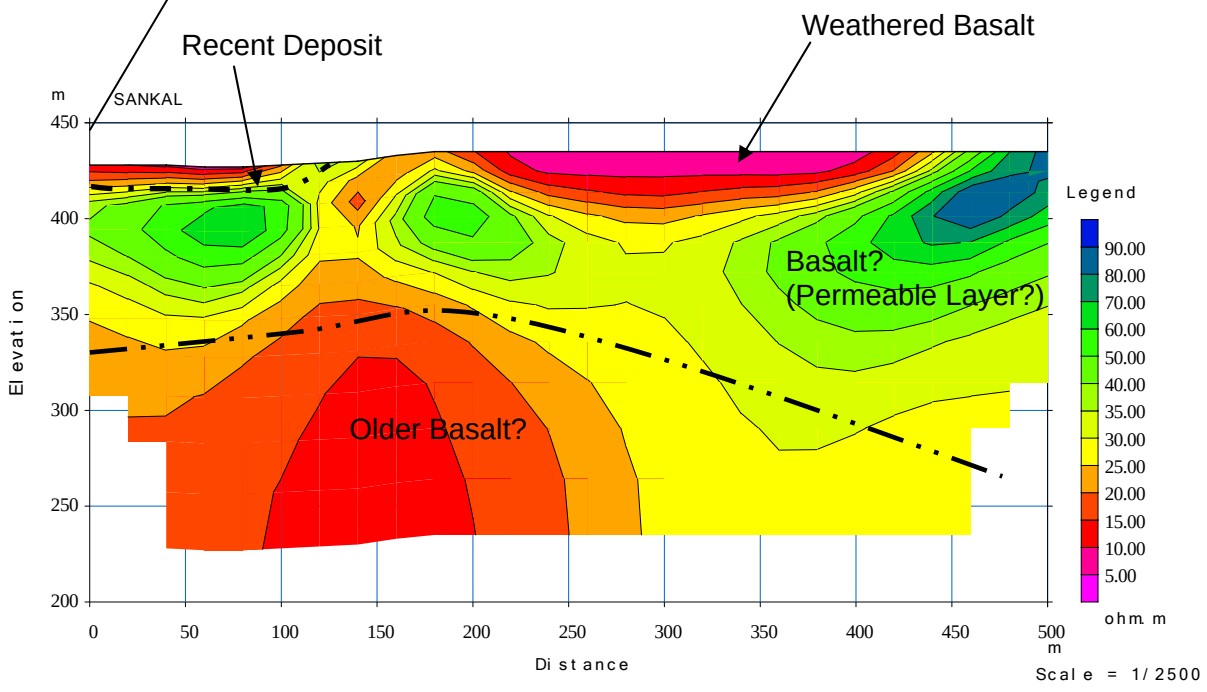
The measurement location is in a lowland area along the national road towards Dikhil. It is at the skirt of a mountain and the topography shows that the catchment area is small and salt content is easily accumulated. Groundwater flowing down from the mountains (basalt) distributed in the upper stream is the objective of the development. From the results of the profiling, it is expected that an older lacustrine deposits, in which salts have accumulated, is widely distributed and the area of basalt is limited only to the starting point of the profile line (thickness is approximately 50 m), because a low resistivity zone of less than 10 Ω·m is distributed. Therefore, the potential for water development is considered to be low.



(7) SANKAL

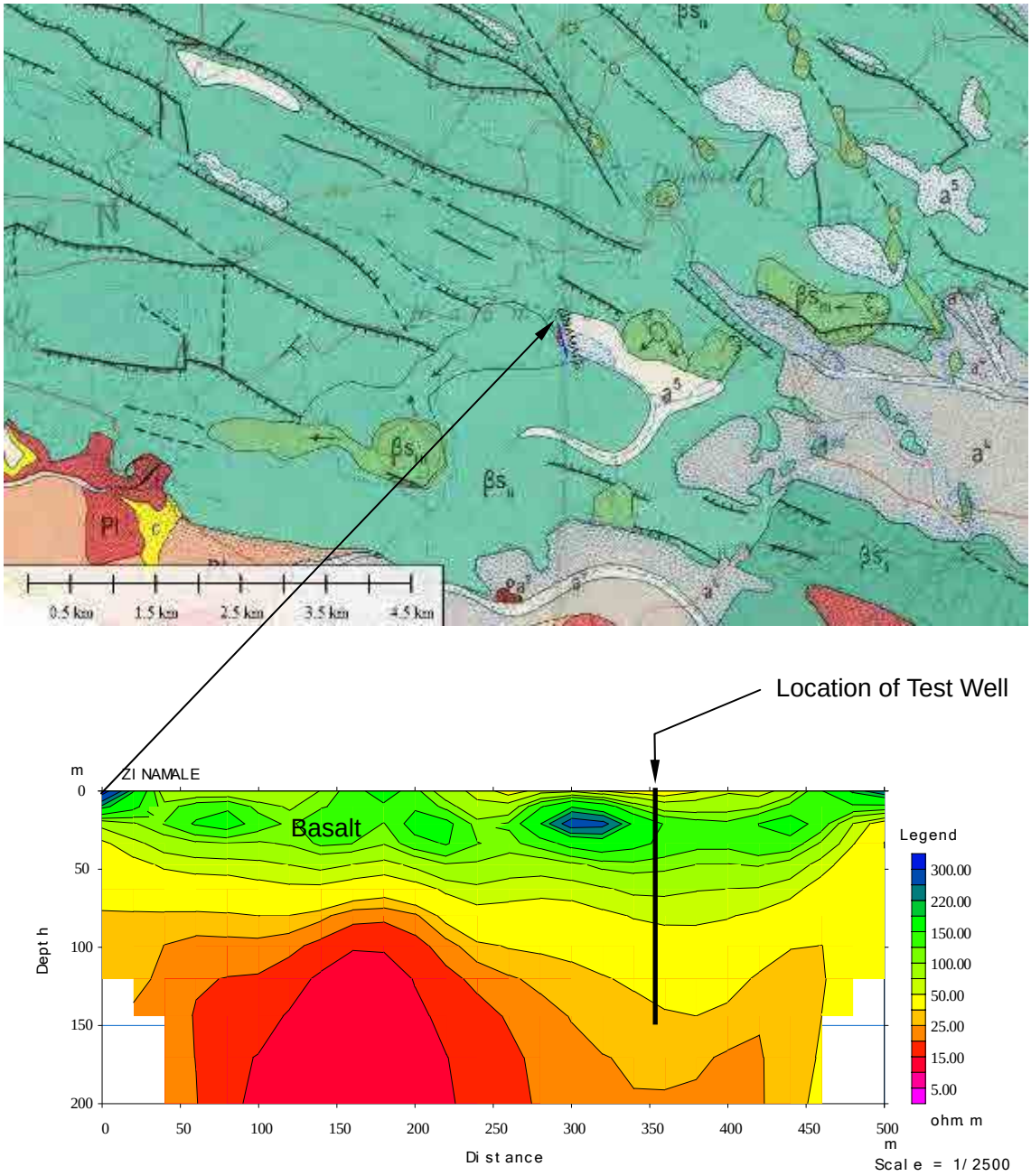
Sankal is a city located to the south of Dikhil and the boundary of Ethiopia. Access to water resources is poor and the need for water development is high. From results of electrical profiling, a high resistivity zone of more than 30 Ω·m is widely distributed and it is expected that basalt extends widely, i.e. a highly permeable zone is estimated. However, the catchment area is narrow and it is anticipated that the recharge storage is limited and continuous development of groundwater will be difficult. In fact, several attempts at water wells by other donors have all failed.





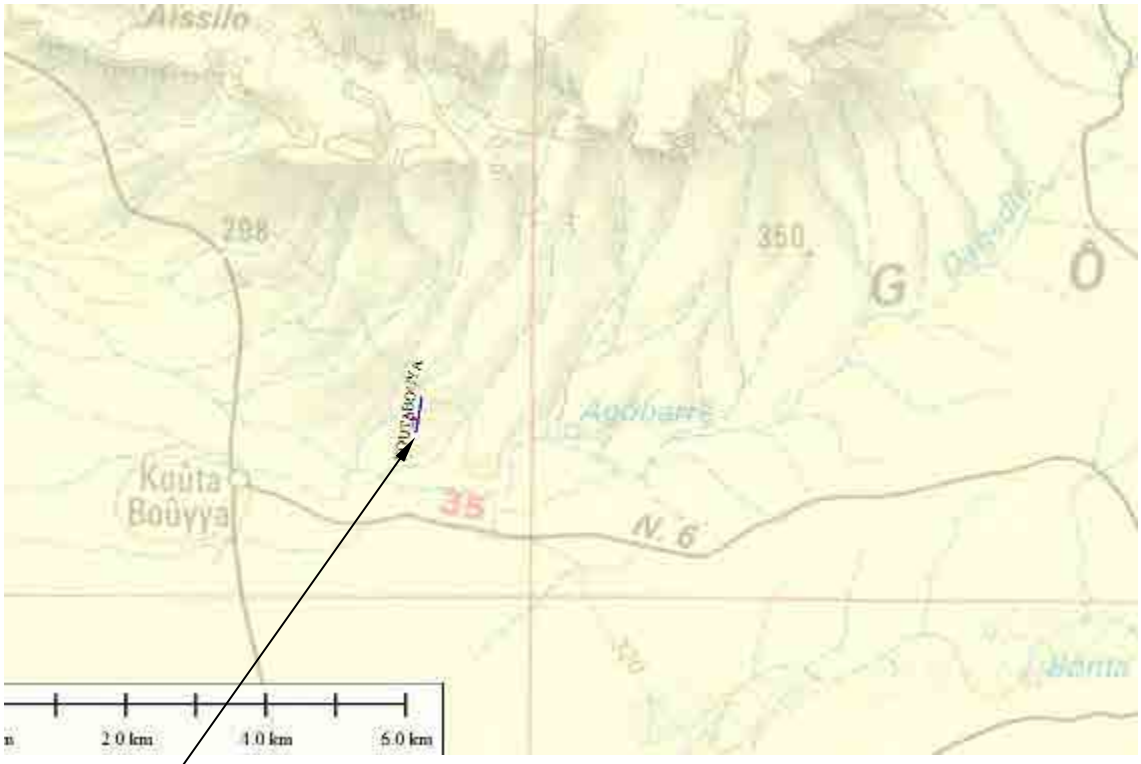
(8) ZINAMALE

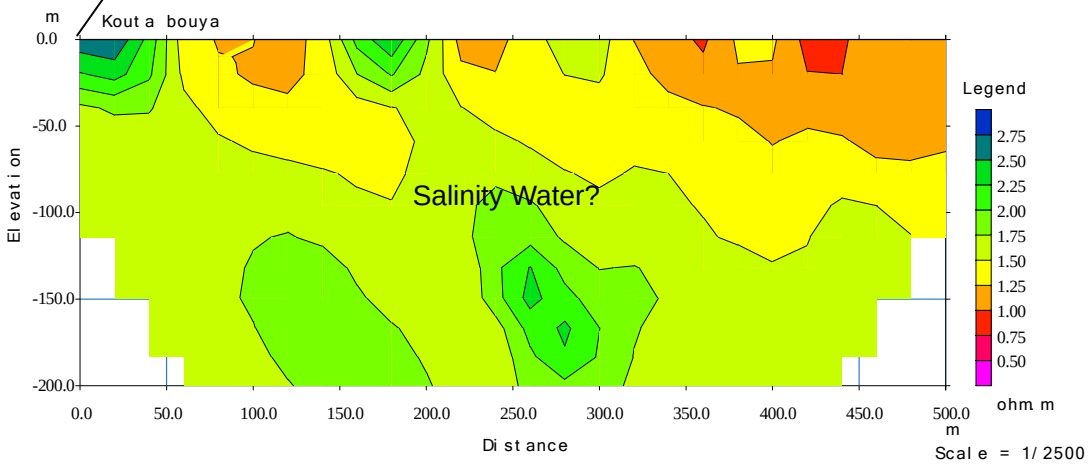
It is located between Hanle Wadi and Gobbad Wadi in an area where basalt is widely observed. A high resistivity zone of more than 50 Ω·m is widely distributed and basalt is expected to extend to the underground. Reference material provided by MAEM-RH shows the depth of the groundwater is approximately 50 m. The potential for water development is expected to be high considering the high permeability and existence of groundwater.



(9) KOUTABOUYA

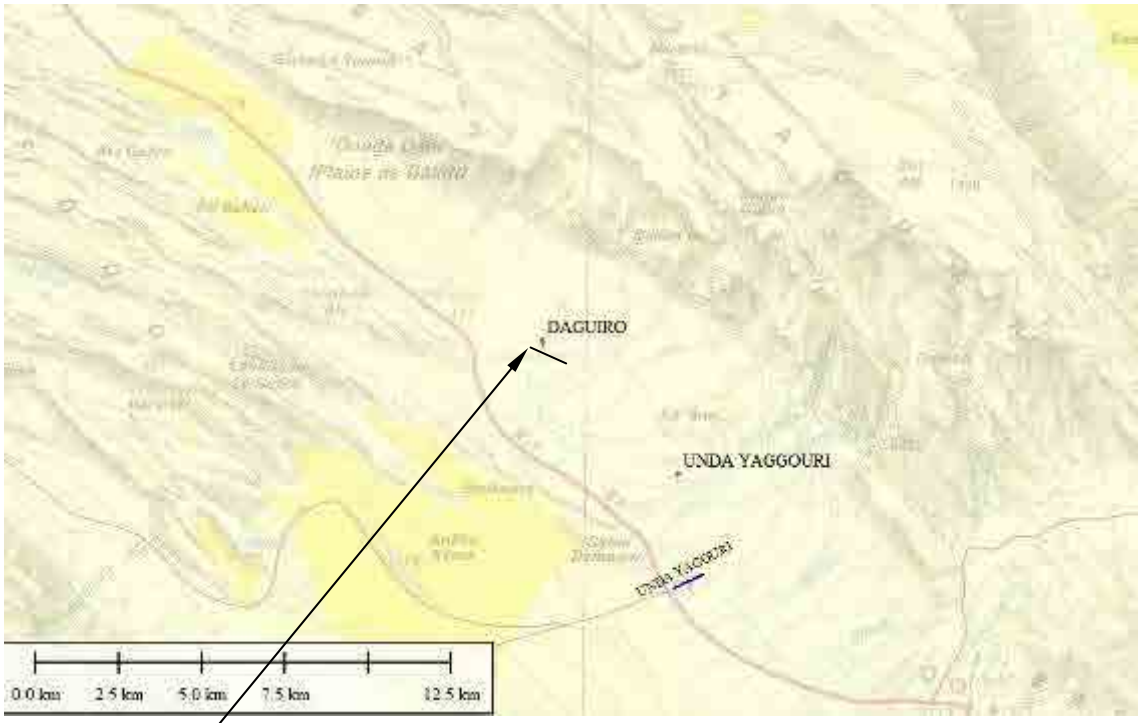
The survey point is located downstream of the GOBAAD watershed. Salinization is anticipated because it is located in the downstream basin. In fact, several wells have been developed but water is not suitable for drinking because of a high salt content.
In this Project, the measurement position was shifted to the upper stream side to avoid saline water. However, a low resistivity zone of less than 3 Ω･m is widely distributed and groundwater with a high salt content is expected.

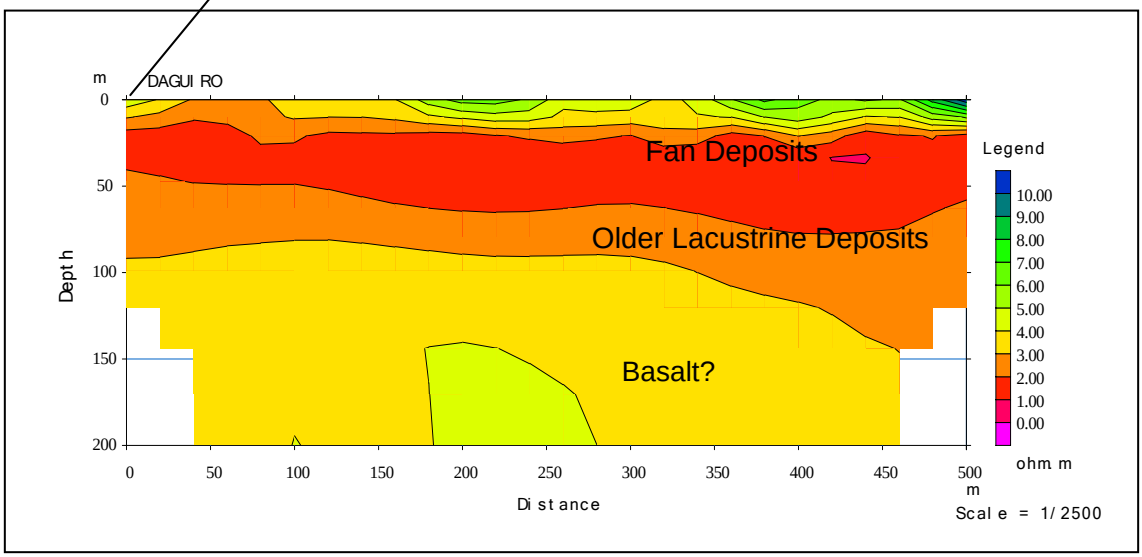




(10) DAGUIRO

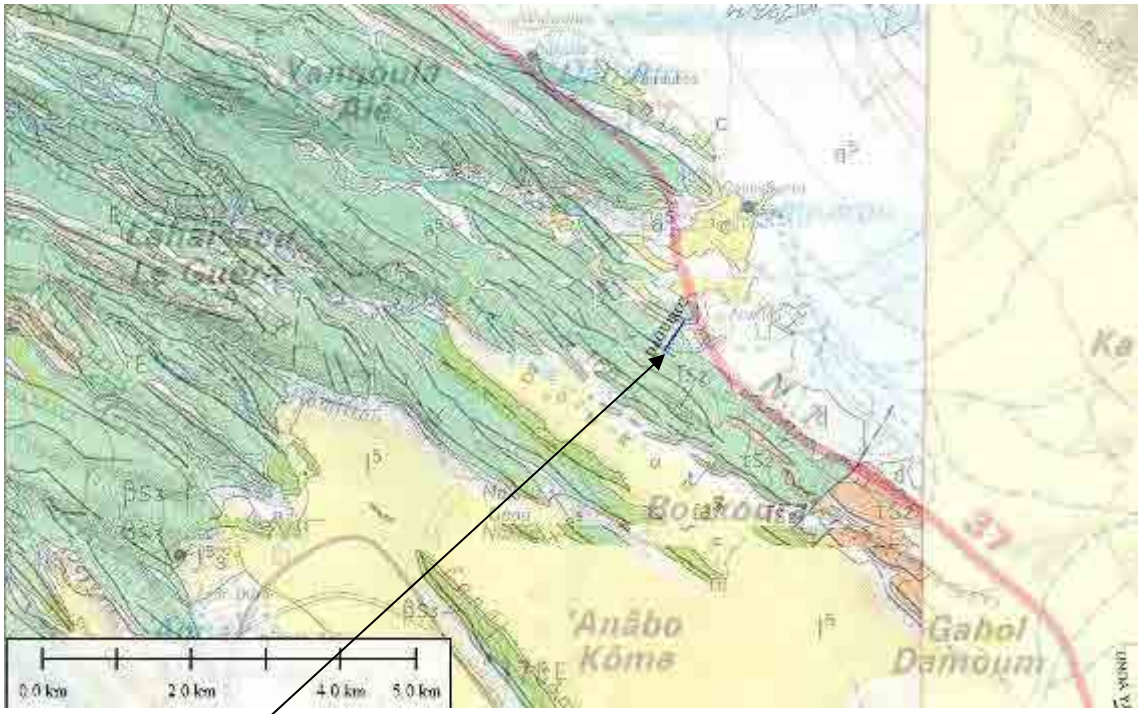
The measurement position is located on Route 1 between Yoboki and Galafi. The location is similar to Unda Yaggouri 1 and is not suitable for water development because older deposits are widely distributed and salinization is anticipated. The measurement position was thus shifted to a high elevation area on the skirts of the northeast side to avoid lowland areas as much as possible. However, a low resistivity zone was widely observed (below 5 Ω・m) and saline water is anticipated.

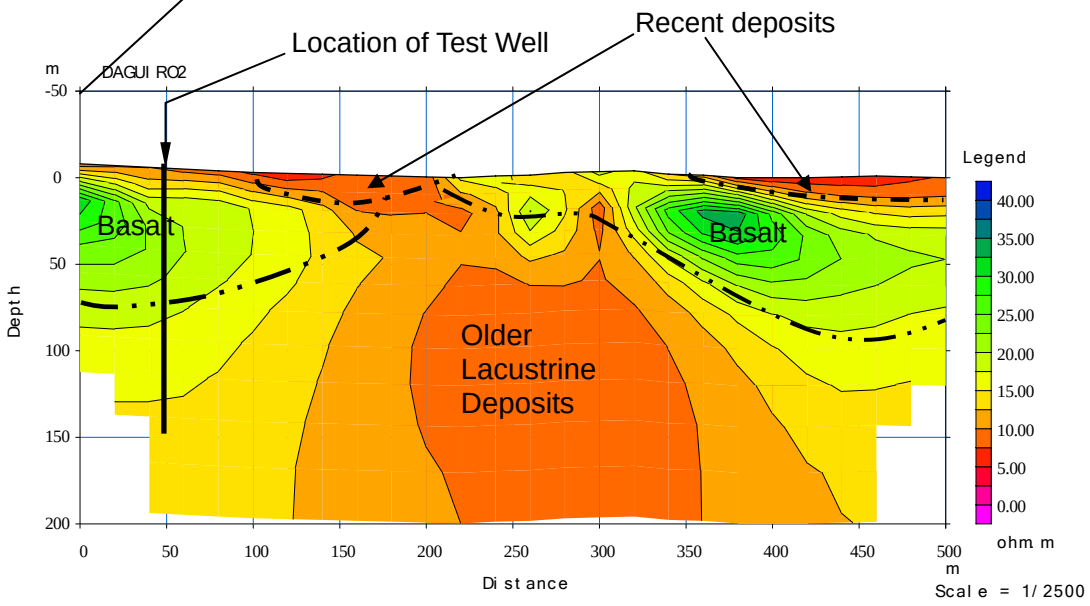




(11) DAGUIRO(2)

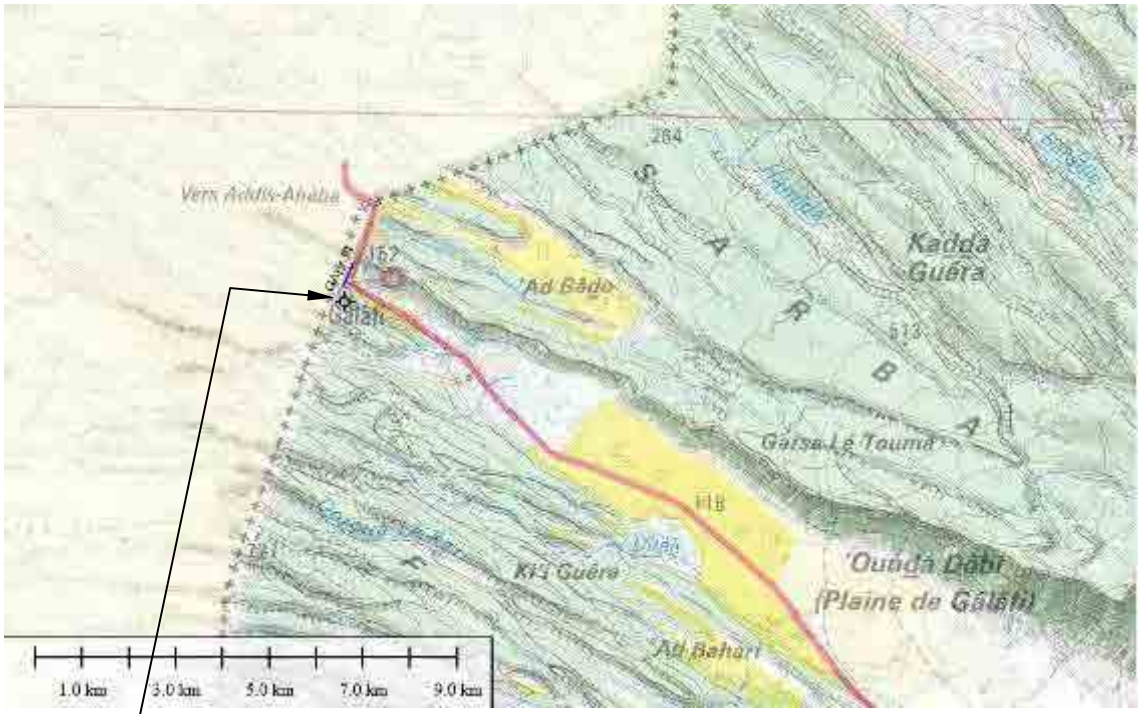
The survey point is located at the south side of Route 1 between Yoboki and Galafi. In Galafi located at the upper stream, groundwater is retrieved from basalt distributed in the surrounding area. Groundwater development is expected at the same basalt lava flow.
A low resistivity zone of less than 10 Ω･m is distributed in the central area and older lacustrine deposits with highly saline water are estimated. On the other hand, at both starting and ending points of the profile line, high resistivity zones were observed and the distribution of basalt is expected.
Therefore, a Test Well was drilled at the 50 m point.

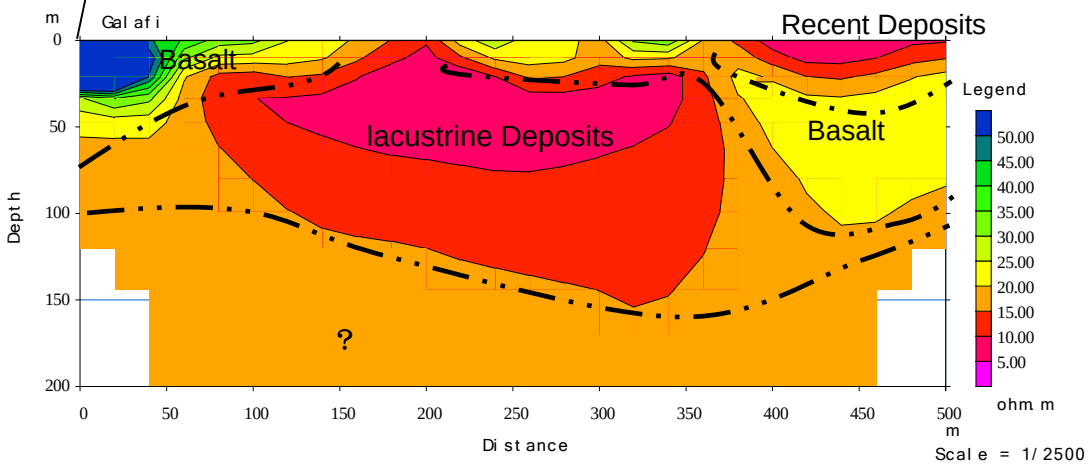




(12) GALAFI

Galafi is at the national border along Route 1. Basalt is widely observed in the surrounding area. On the other hand, the Hanle basin located in the southeast, shows distribution of lacustrine deposits and groundwater with a high salt content is anticipated.
Results of electrical profiling show wide distribution of a low resistivity zone of less than 20 Ω･m with an area with a resistivity of 25 Ω･m being observed at the end of the profile line where existence of basalt is expected. However, this area is under the management of the military and therefore excluded from the candidates for the pilot location due to the possibility of the difficulty of maintenance by residents.



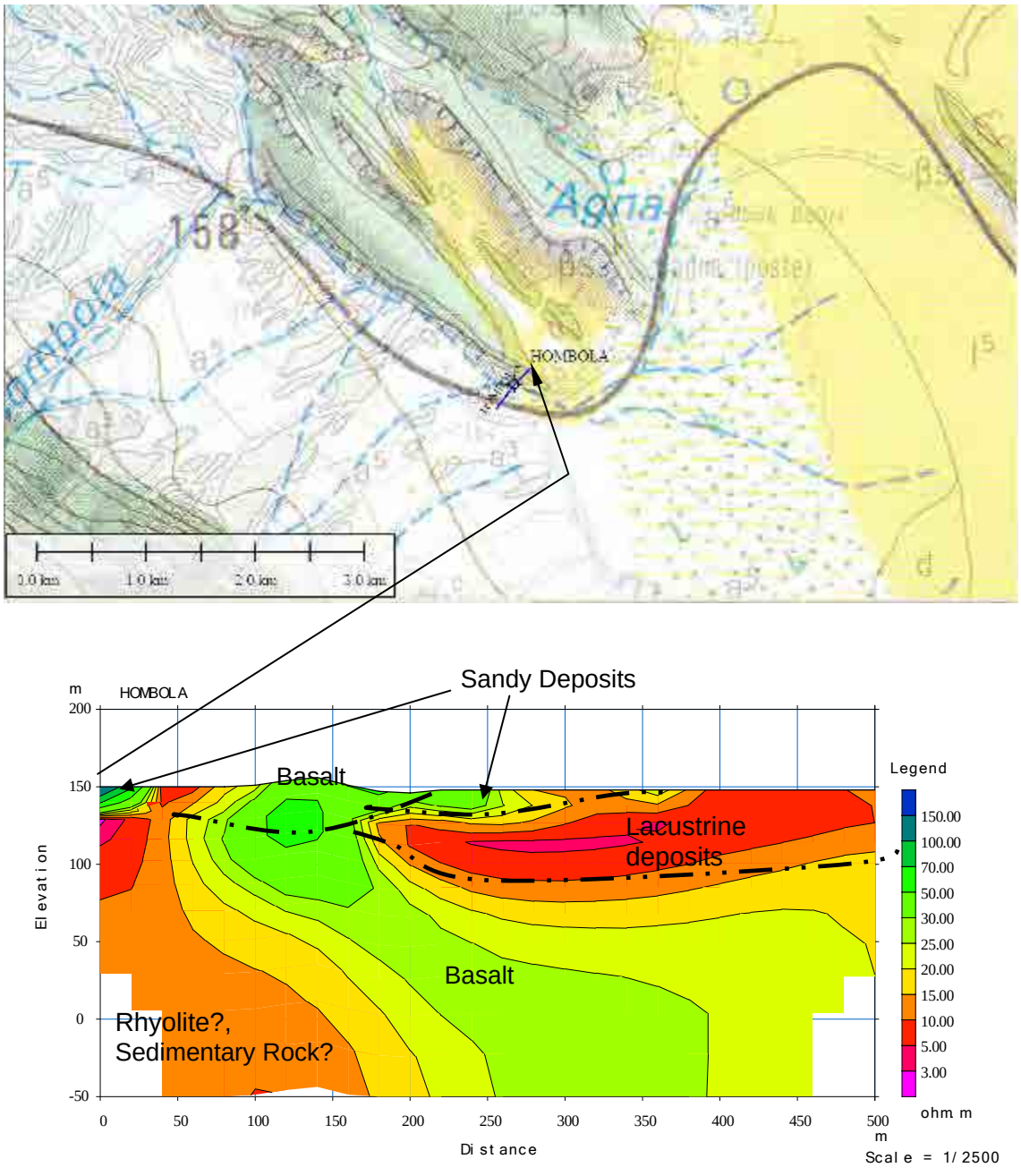


(13) HAMBOLA

Hanbola is located downstream of the Hanle basin, which is the internal drainage basin, and it is widely covered with lacustrine deposits. Highly saline water is anticipated in the lacustrine deposits. Therefore, basalt in the surrounding area is considered as an objective for groundwater development.

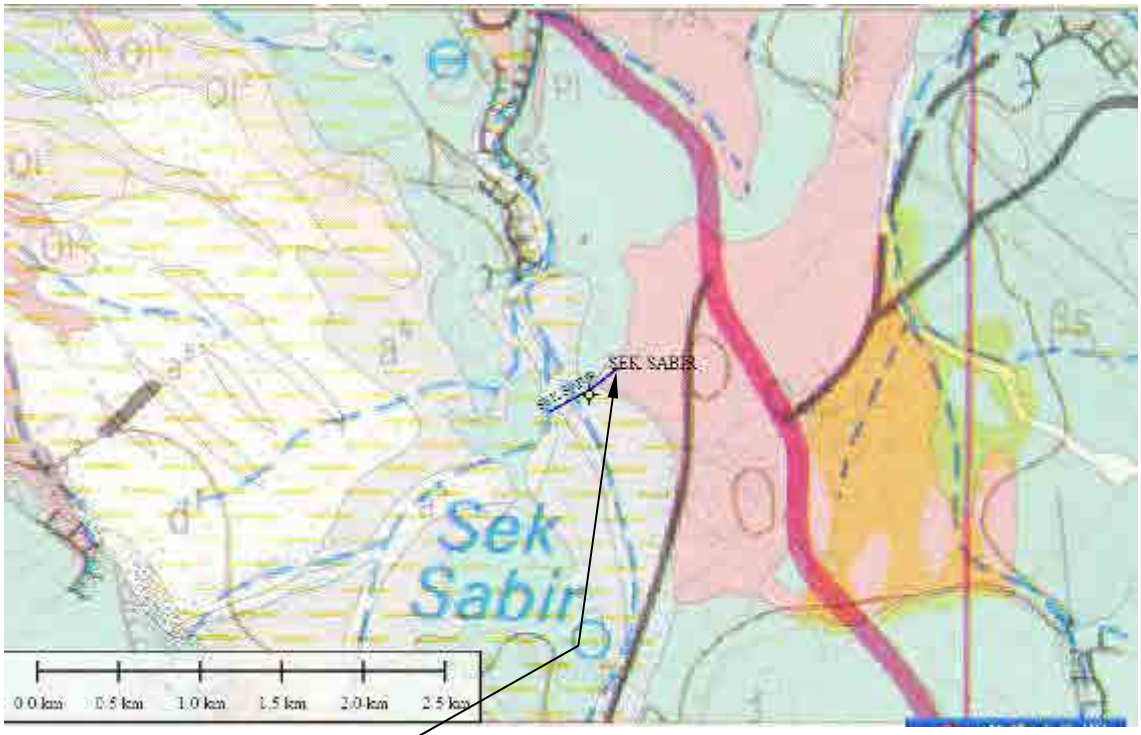
The results of electrical profiling indicate the distribution of resistivity of more than 25 Ω·m for the first half of the profile line (northeast side) and shows a possibility of basalt distribution. On the other hand, it shows the distribution of low resistivity of less than 25 Ω·m (at 100 m from the ground) for the latter half of the line (southwest side) and a thick lacustrine deposit is estimated.

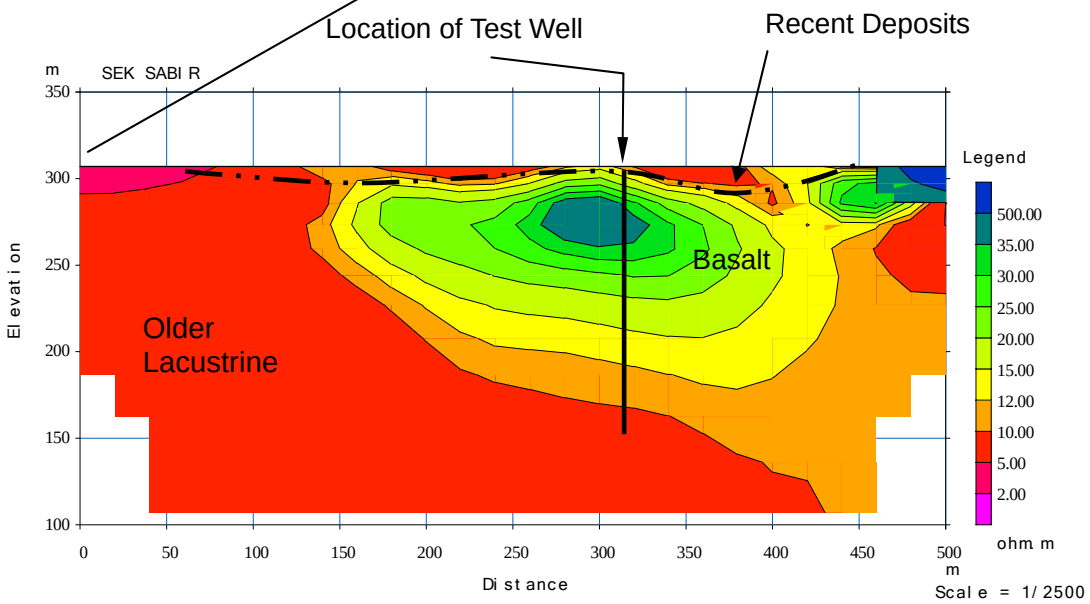
Roads in this area flood during the raining season. Thus, road maintenance work will be necessary when wells are constructed by this Project.



(15) SEK-SABIR

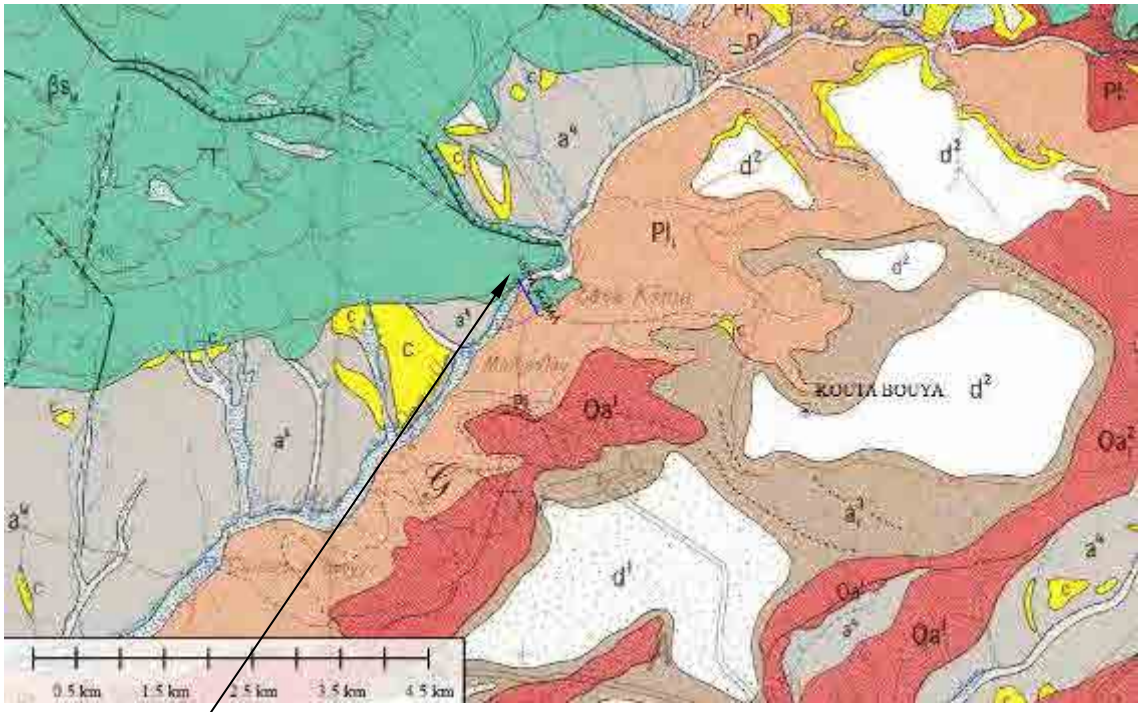
It is located in the middle stream of a wadi in Hanle watershed, and the salt content of groundwater in surrounding wells is relatively low. River deposits are observed in the wadi while basalt is found in the right bank of the wadi. Results of electrical profiling show high resistivity (above 20 Ω・m) in deep areas and the left bank (east side) of the wadi, and an basalt aquifer is expected. Thickness of the aquifer is estimated at 150 m and the potential for water development is fairly high.

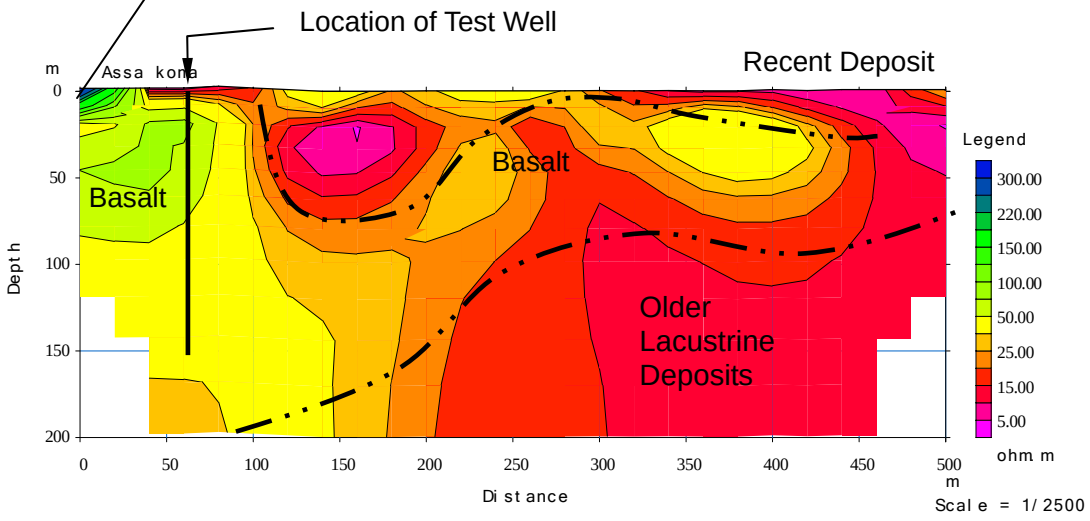




(16) ASSA KOMA

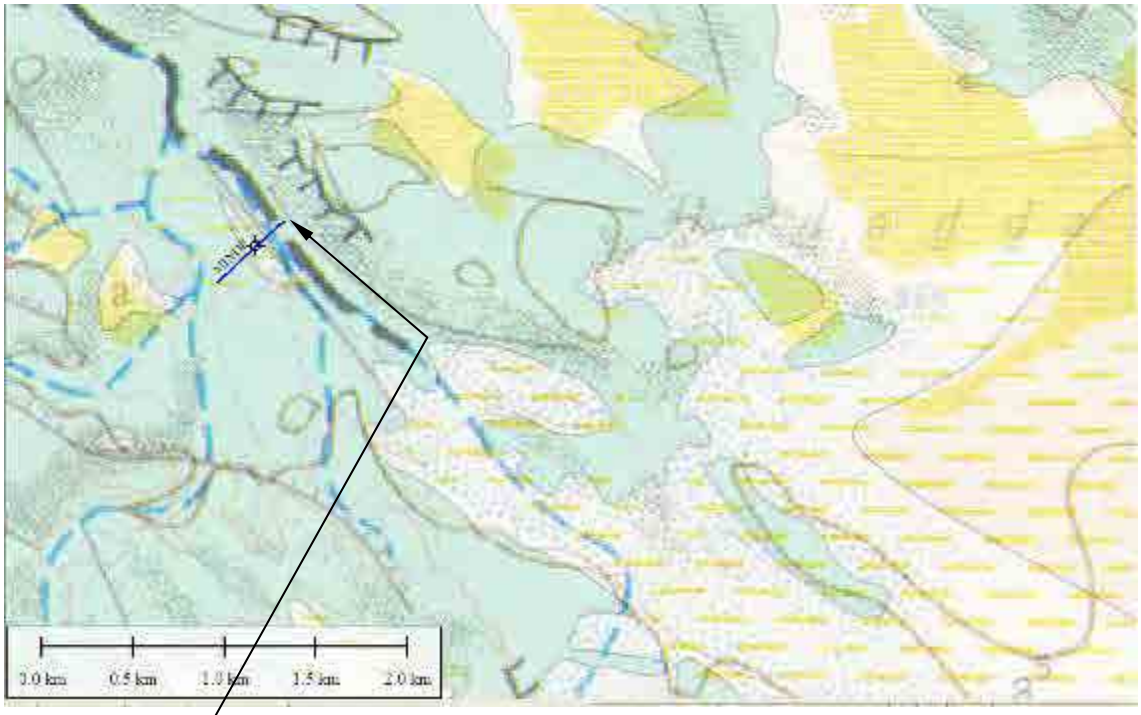
Assakoma is a town located in the middle stream of Kouta Bouya watershed. In comparison with Kouta Bouya, which is located at the lower stream, it is expected that there is little salt accumulation. Basalt is distributed in the surrounding area and this basalt is the objective of the water development. Results of electrical profiling indicate that low resistivity of less than 25 Ω･m and high resistivity of more than 25 Ω･m are distributed in a complicated manner. This is interpreted as being caused by sedimentary deposits that were formed in a lowland area generated by a down flow of basalt.
From this interpretation, the estimated relatively thick basalt lava distribution area at the start point of the profile line is considered as a potential water development point.

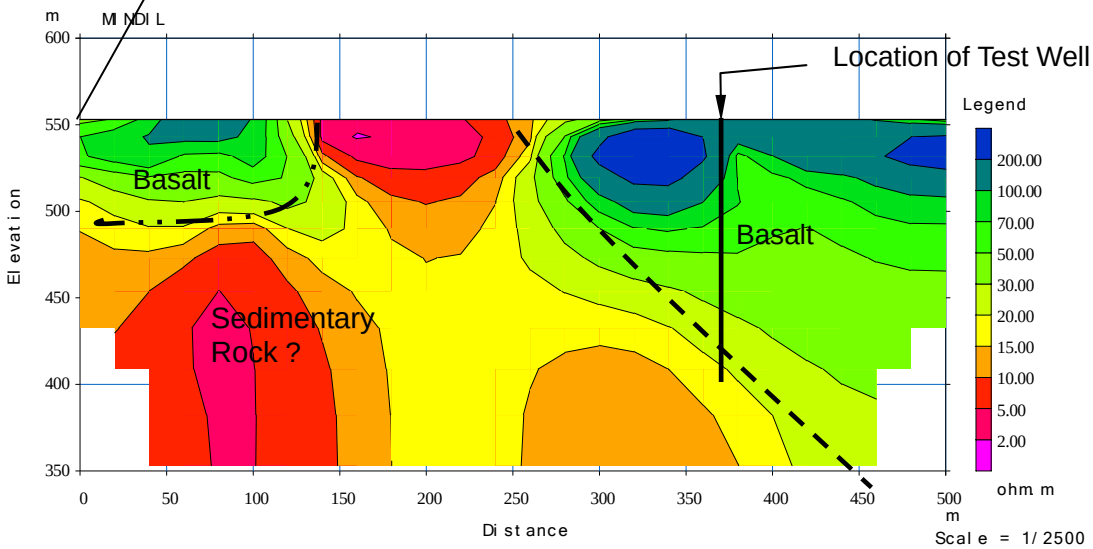




(17) MINDIL

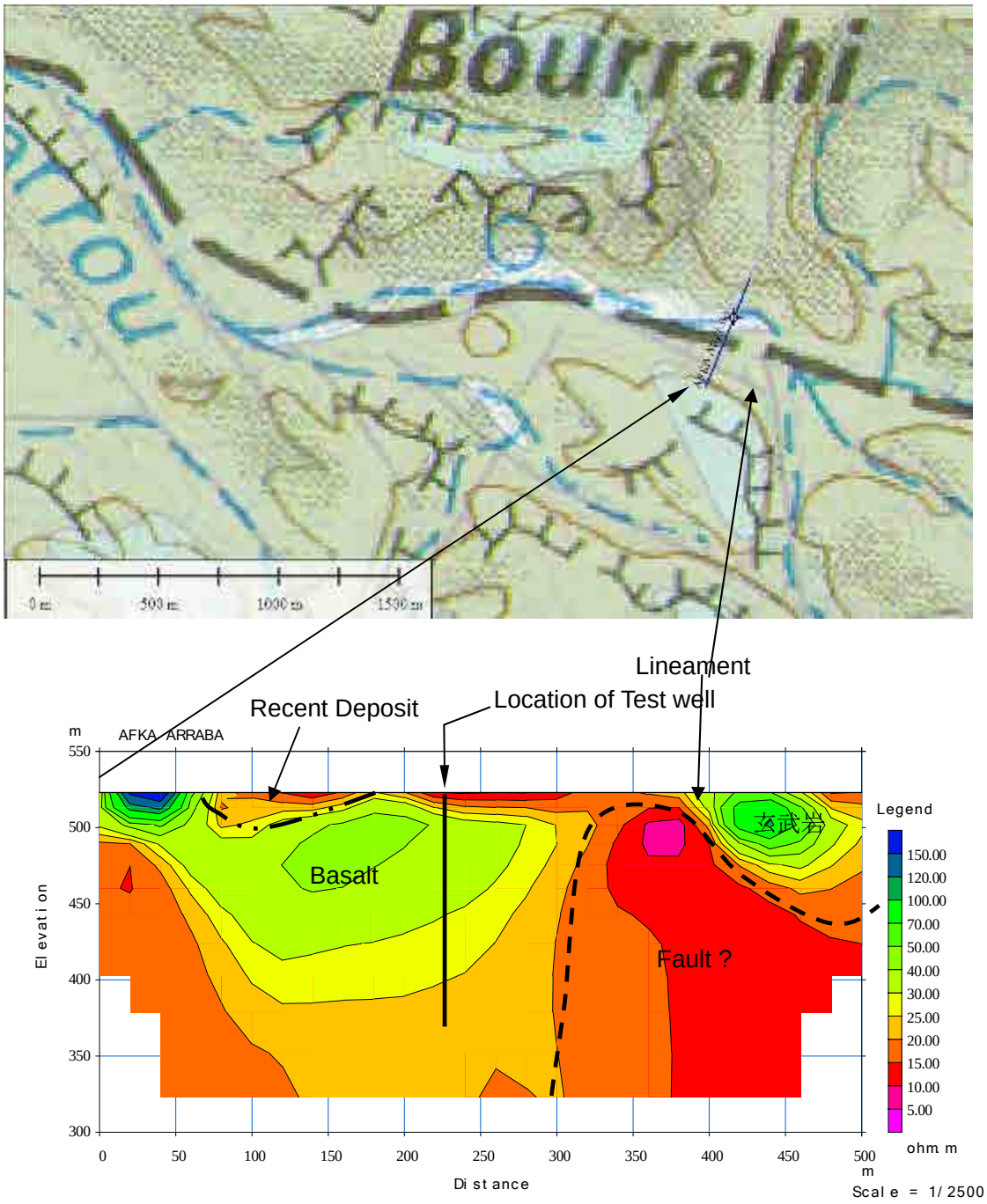
It is located at the basalt lava plateau at the upper stream of the GAGGADE basin. A highly permeable aquifer is expected, if sufficiently deep basalt is distributed in the vicinity .
Results of electrical profiling show that a high resistivity zone of more than 20 Ω·m is thicker for the latter half of the profile line and basalt lava, which has a possibility for use as an aquifer, is thick in this part.





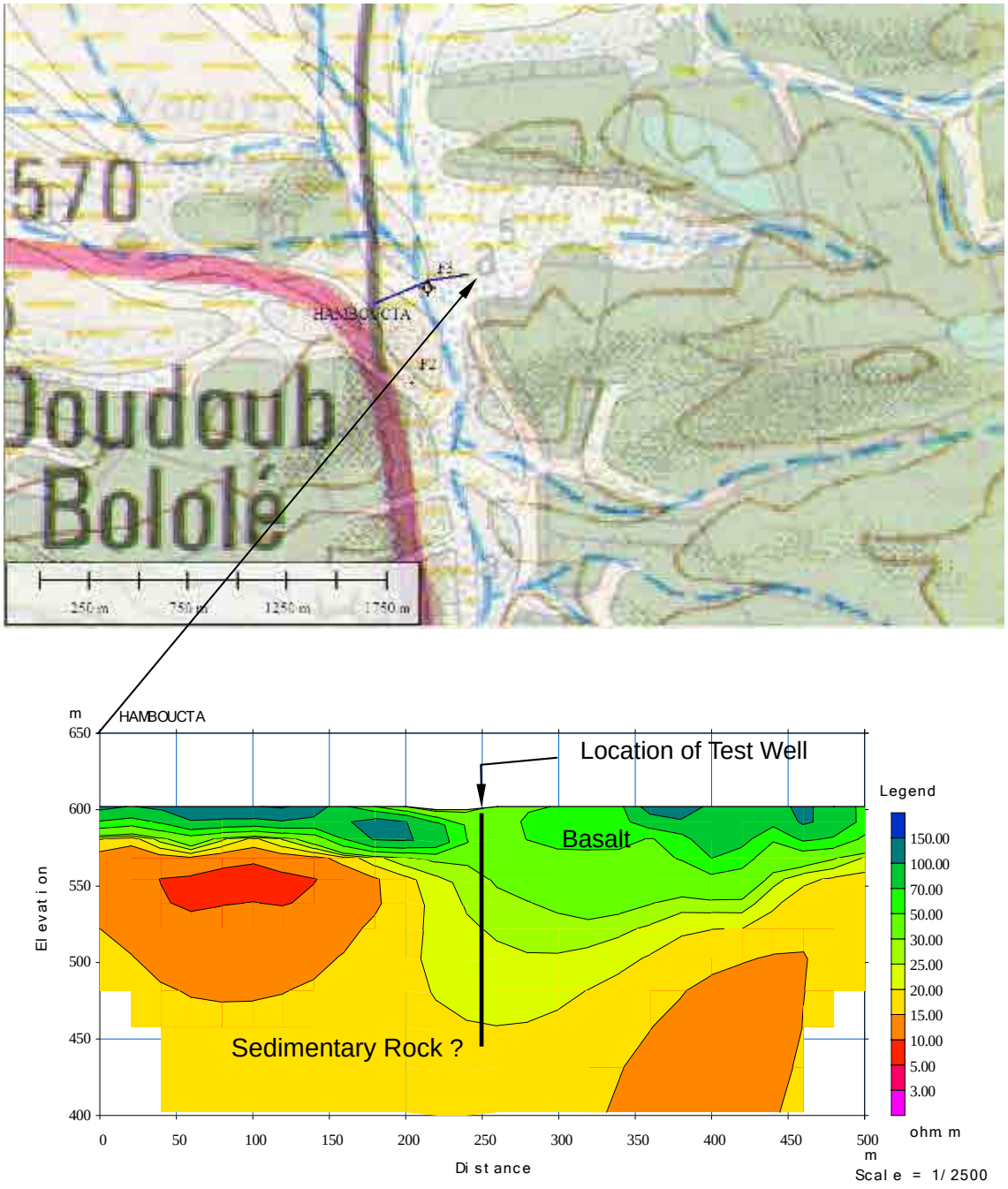
(18) AFKA ARRAB

Basalt is distributed in the surrounding area and a highly permeable layer is expected. A low resistivity area showing vertical structure is observed at 300 to 500 m from the profile line. This structure has a high possibility of a fault, since the existing geological map indicates a lineament in this area. This fault is assumed to be a fault gouge because of its low resistivity. Therefore, the potential for water development in this area is judged to be low. On the other hand, the possibility for water development in the former half of the profile line (north northeast side), where a high resistivity zone is widely distributed, is estimated to be high.



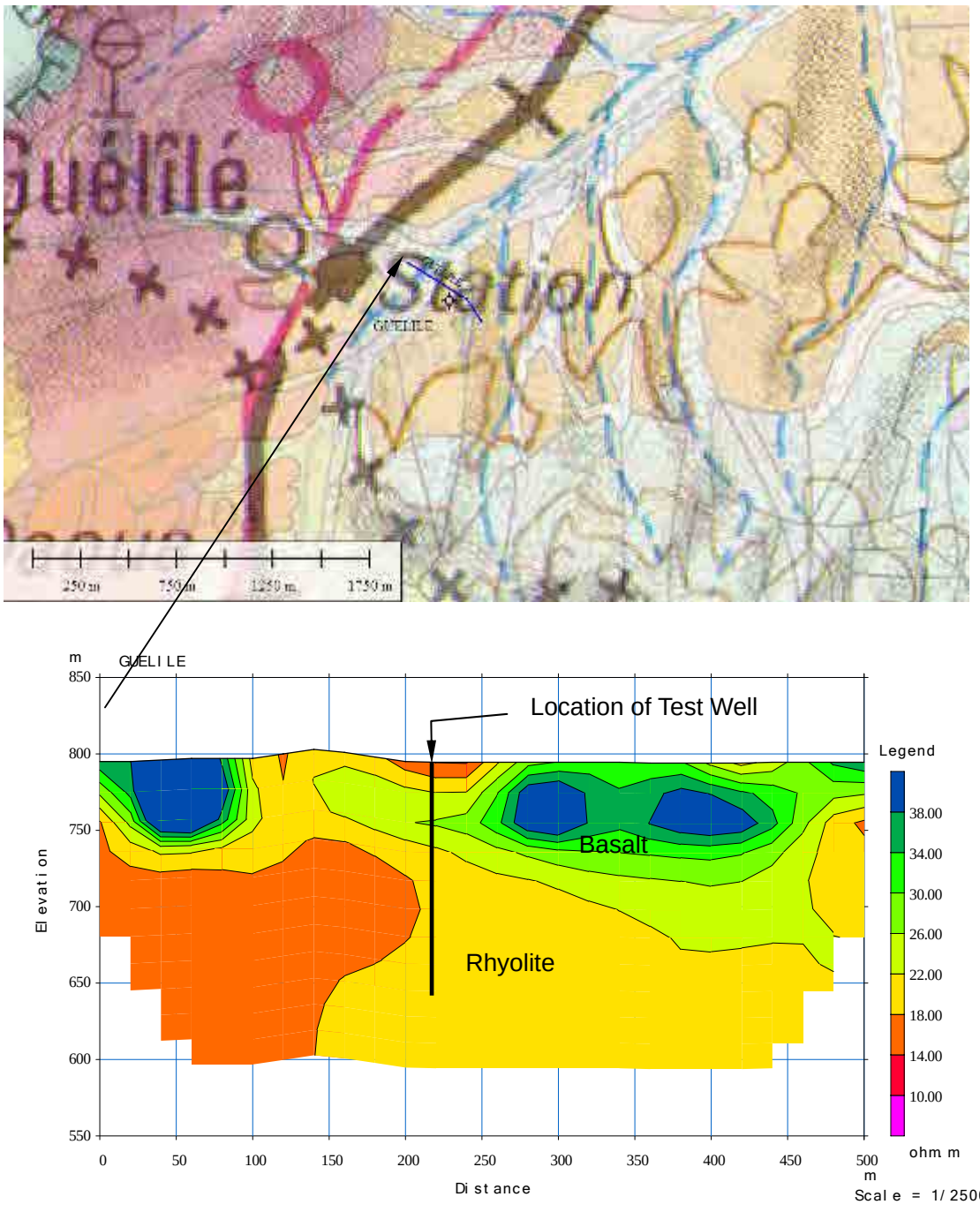
(21) HAMBOUCTA

This measurement position is located in the upper stream of Hanboucta Wadi, which is flowing into Grand Bara. Basalt is observed in the surrounding area and high permeability is expected. Results of electrical profiling indicate the wide distribution of a low resistivity (less than 20 Ω·m) zone for the first half of the profile line. On the other hand, a high resistivity zone of more than 20 Ω·m is distributed at 100 m in depth for the latter half of the profile line, i.e. in the left bank (west side) of the wadi. This is estimated to be basalt to a depth of 100 m.



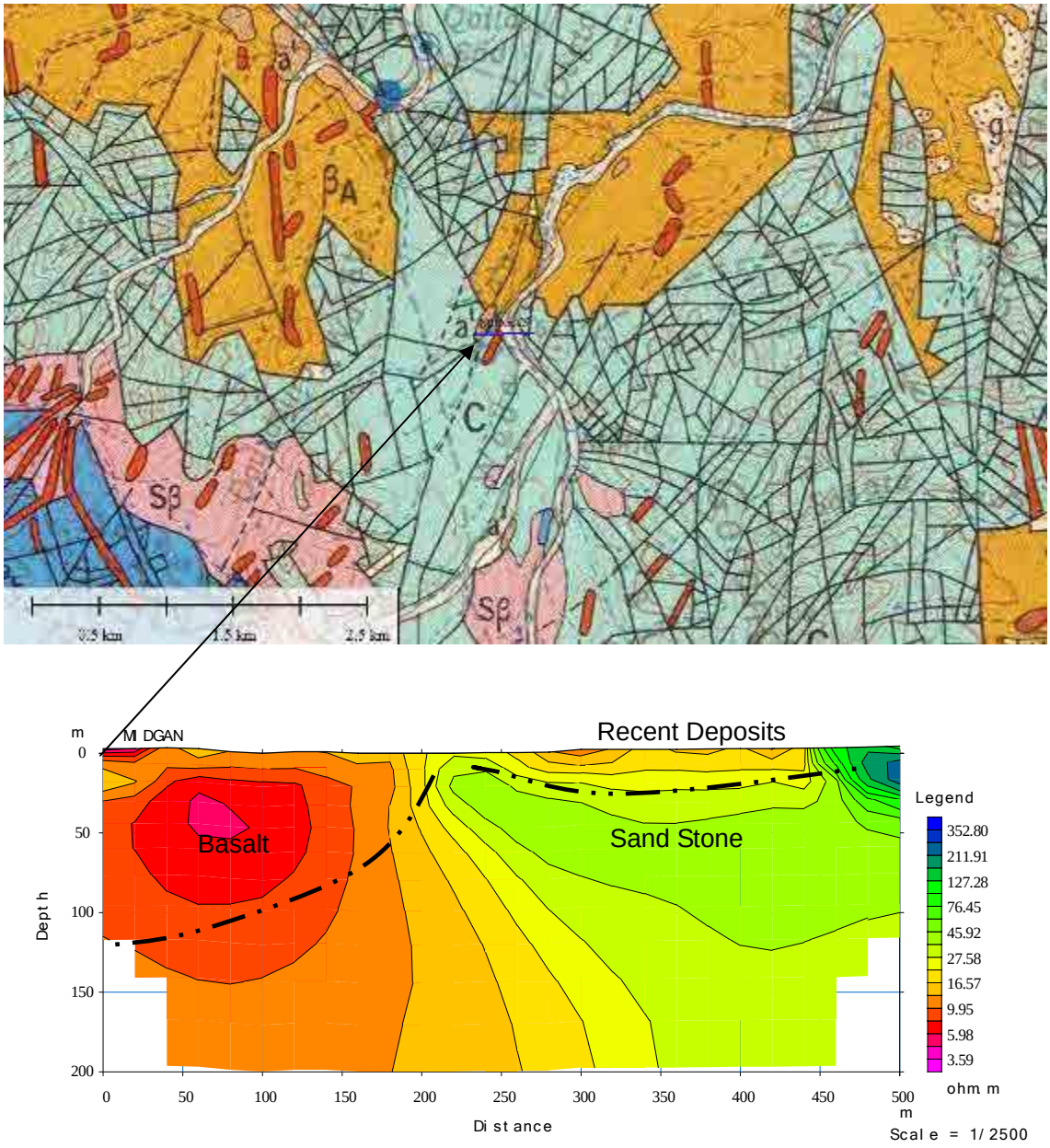
(22) GUELILE

Rhyolite and basalt are distributed in the vicinity. The potential for groundwater in the rhyolite is estimated to be relatively high, but the salt content tends to be high and therefore water development in only basalt is advisable. Low resistivity zones of less than 22 Ω·m distributed at a depth of more than 100 m obtained by electrical profiling are estimated to be rhyolite. On the other hand, high resistivity zones of more than 22 Ω·m at a depth of less than 100 m are estimated to be basalt from the surrounding geological conditions.
Therefore, basalt lava less than 100 m in depth is to be the objective for water development, but it will be difficult in cases where the groundwater level is deep.



(23) MIDGAN

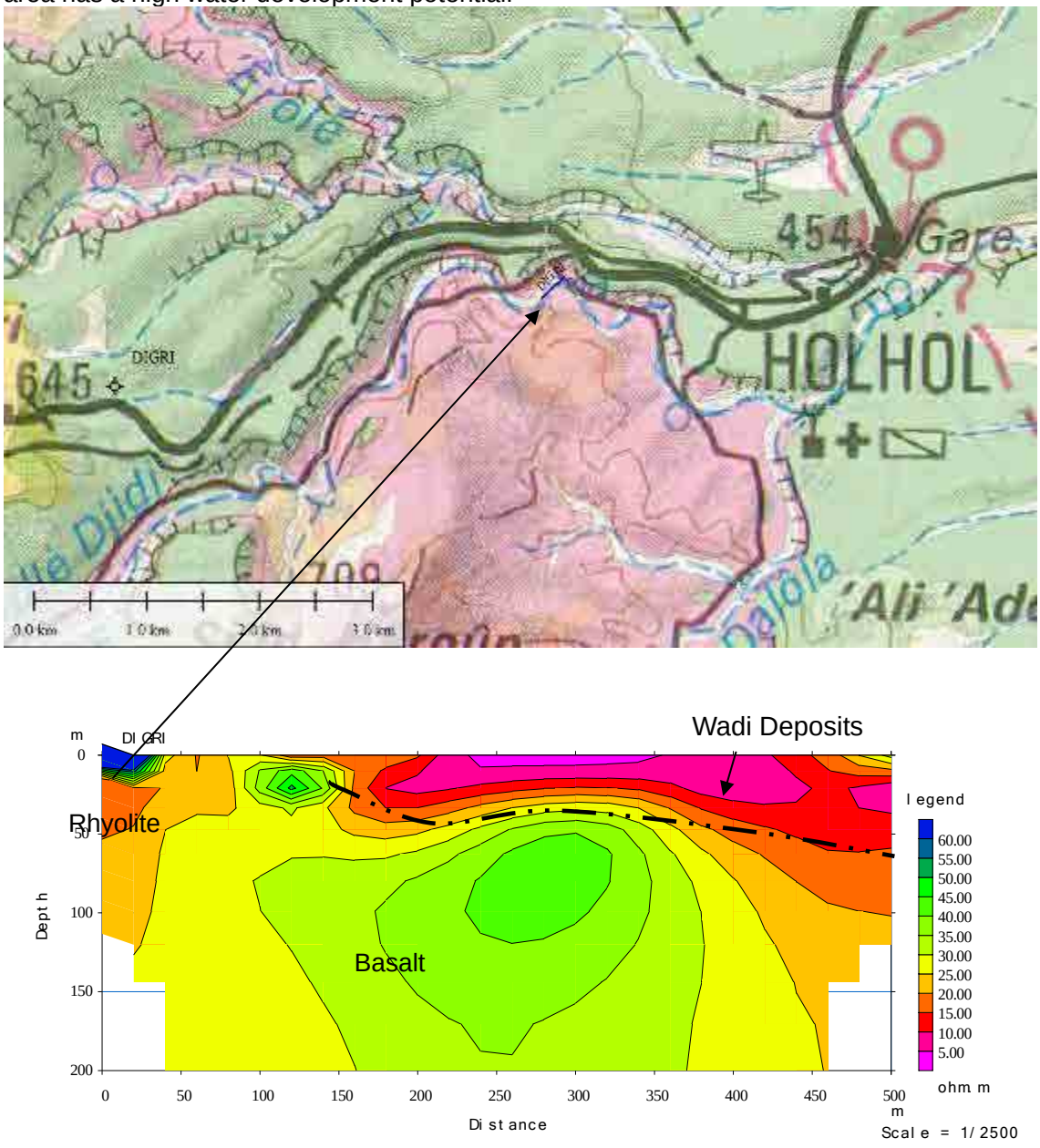
This measurement position is located in the upper stream of the BEYYA ADAY watershed. A sedimentary layer is widely distributed in the objective area. The permeability of the sandstone in the vicinity is confirmed to be low because the sandstone has cracks, which are filled with calcite. Basalt is distributed, but it is mainly observed in the lower stream of the objective point and it is limited in the upper stream area. By electrical profiling, a low resistivity zone of less than 16 Ω·m was observed for the first half of the profile line (west side), and it is estimated from the surrounding geological conditions that the low resistivity zone is consistent with the distribution of basalt. However, characteristics of this basalt are different from Dikhil, where the quality of the water is comparatively good. For the latter half of the profile line, a high resistivity zone of more than 27 Ω·m was observed at a depth of less than 20 m, and it is estimated that sedimentary rock with low permeability is distributed at a shallow depth; thus, the potential for groundwater development is low.



(24) Digri

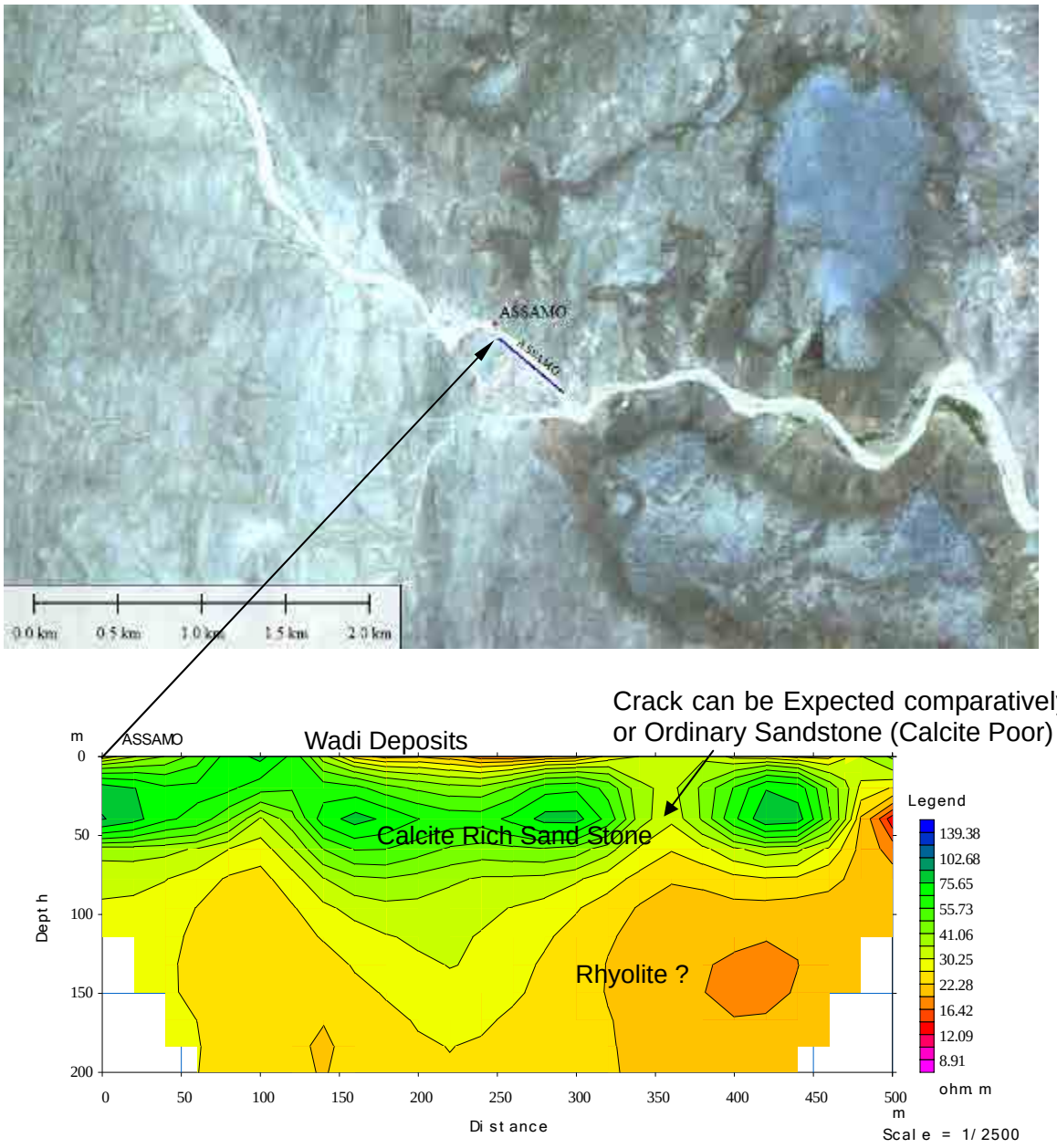
The proposed area Digri is located at the top of the lava plateau and topography shows difficulty for accumulation of groundwater. Therefore, it was necessary to go down to the surrounding wadis for groundwater development. The road to the surrounding wadis was closed due to fallen rocks and access to the wadis was not possible. Therefore, we conducted electrical profiling at the lower stream area and we estimated the geological structure of the proposed area in the upper stream from the geological structure of the lower stream.

The results of the electrical profiling show that an area with low resistivity of less than 20 Ω･m is distributed at the southeastern side of the profile line. This zone is estimated to consist of rhyolite. A high resistivity (more than 30 Ω･m) area at the center of the line at a depth of more than 40 m is estimated to be basalt from the surrounding geological conditions and this highly permeable layer is expected to be widely distributed. From the above conditions, this area has a high water development potential.



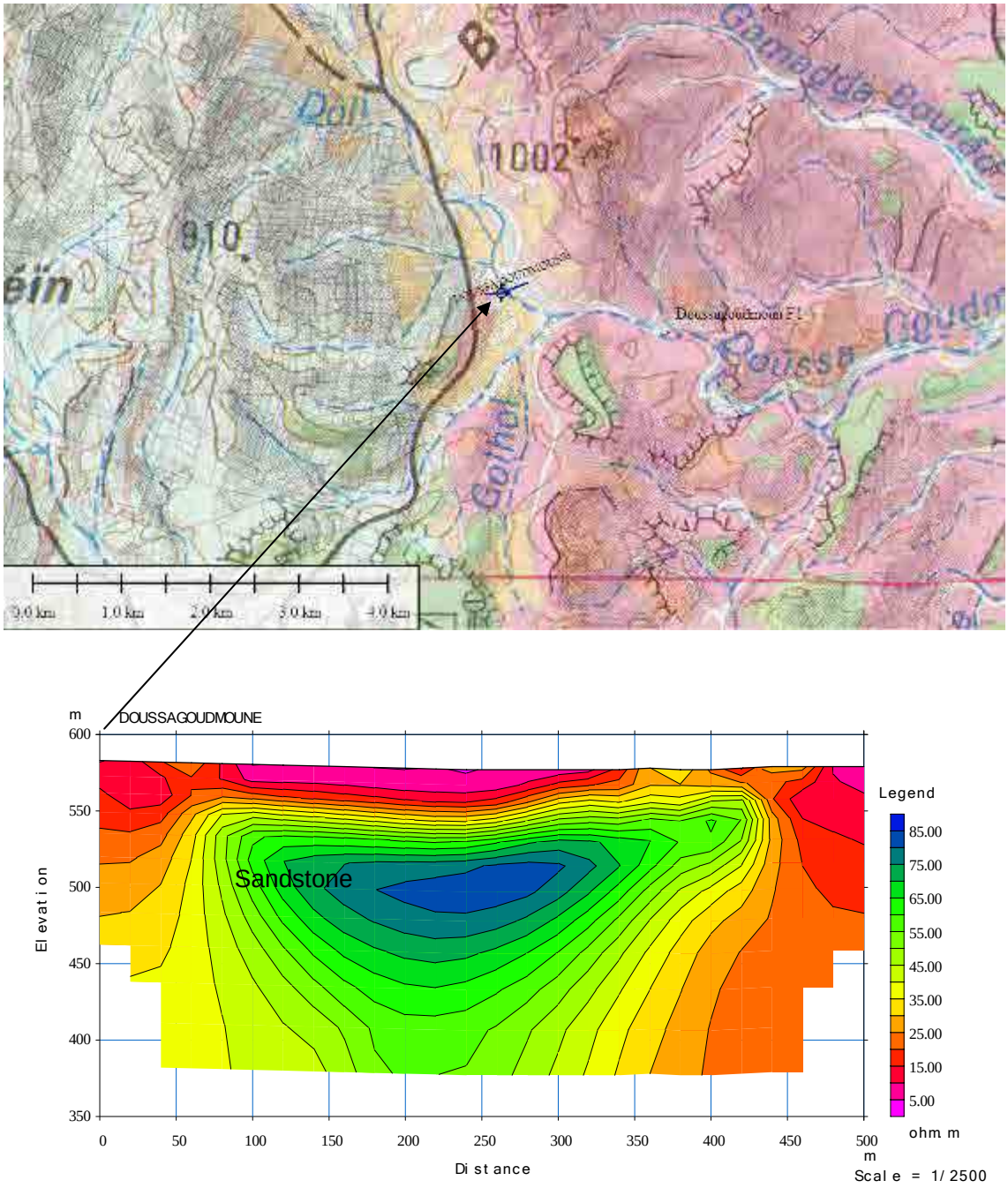
(25) Assamo

The location is at the HADADOU river of the BEYYA DADER basin. This river flows down to Somalia. In the vicinity of the location, sedimentary rock is distributed and it is confirmed that the rock has cracks but they are filled with calcite and show low permeability. Through electrical profiling, it was found that a high resistivity zone of more than 55 Ω･m is distributed horizontally at a depth of shallower than 100 m. At a depth of more than 100 m, a low resistivity zone with less than 55 Ω･m was observed and estimated to be rhyolite from the geological conditions of the surrounding area.
The vicinity has been well developed by US Forces and the salt content is high. Because of this high salt content and considering the geological conditions of the site, the well must be drilled into the thermal metamorphic rock. Therefore, for water development at this site, high salt content is anticipated and the development of drinkable water is assumed to be difficult.



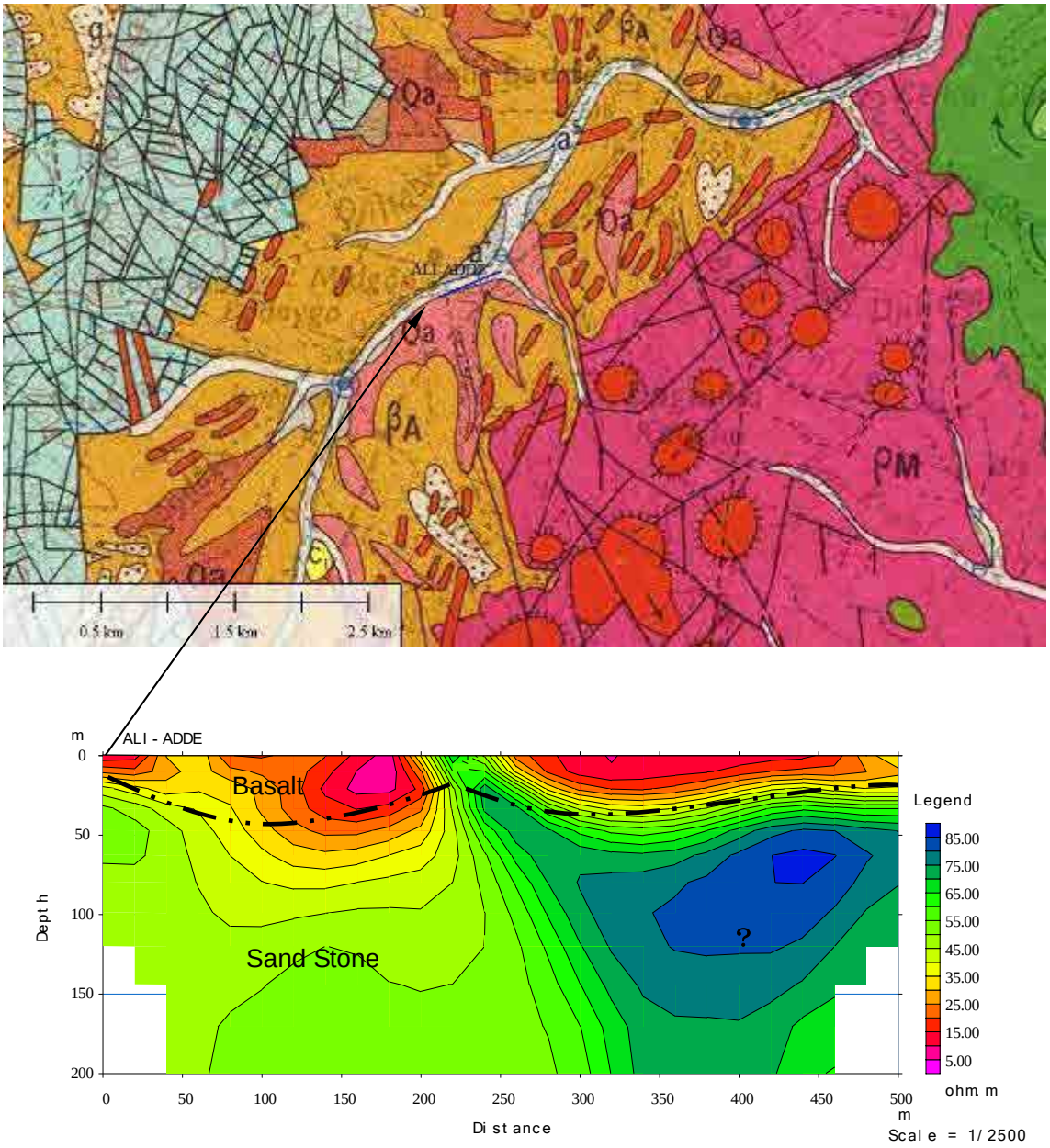
(26) DOUSSAGOUDMOUNE

This point is located at the upper stream of the DOUSSAGOUDMOUNE River in the BEYYA DADER basin. Sedimentary rock and rhyolite are widely distributed in the proposed location. Basalt is also observed but in a limited area. The sedimentary rock has cracks, but these are filled with calcite and the permeability is confirmed to be low similar to the surrounding area. A high resistivity zone of more than 35 Ω･m is widely spread and it is considered from the surrounding conditions and similar geological characteristics that sedimentary rock with low permeability is distributed. Therefore, the potential for groundwater development in this area is estimated to be low.



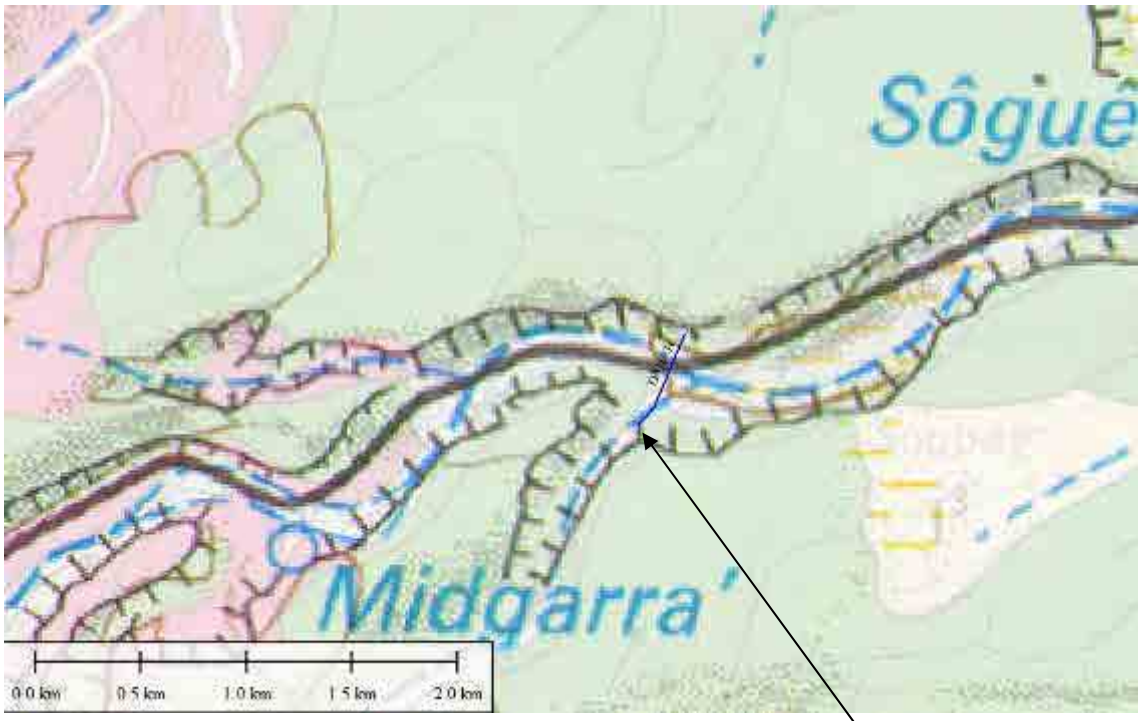
(27) ALI-ADDE

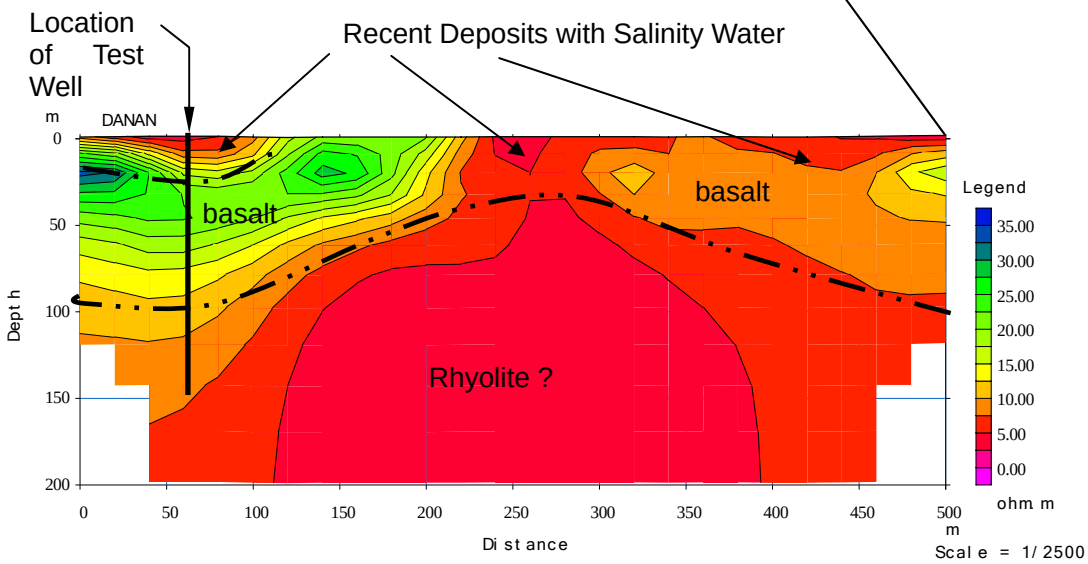
There are refugee camps in this area and the demand for water is high. Several water development projects through international donors and national policy were conducted in this area. But, the success rate is less than 30%. There are also abandoned wells from which water was initially retrieved but became unproductive later.
The results of electrical profiling show that at a depth of more than 50 m, resistivity indicates more than 45 Ω·m although there is a little difference between the former half and latter half (east side and west side) of the profile line. It is estimated from the results of electrical profiling and surrounding geological distribution that sedimentary rock is widely distributed at a depth of more than 50 m and the small difference in resistivity is due to the presence of calcite filled cracks. Thus, the potential for water development in this area is estimated to be low.



(29) MIDGARRA

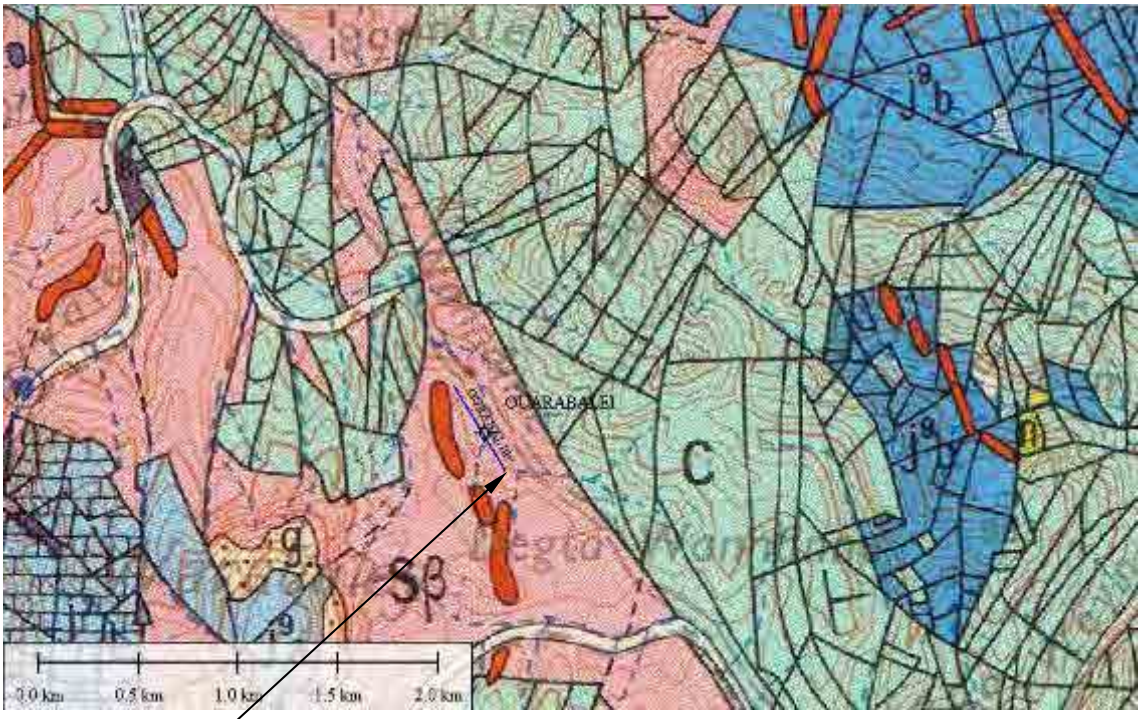
In the surrounding area, the potential for the water development is estimated to be low in spite of the demand for water. Results of profiling show that at a depth of 50 m to 100 m, resistivity of more than 10 Ω·m is distributed while resistivity of less than 10 Ω·m is distributed in deeper areas. This low resistivity zone in the deep areas is estimated to be rhyolite considering the surrounding geological conditions. The high resistivity zone of more than 25 Ω·m, which is distributed in the first half of the profile line (north side), is considered to be basalt and water development is being considered.

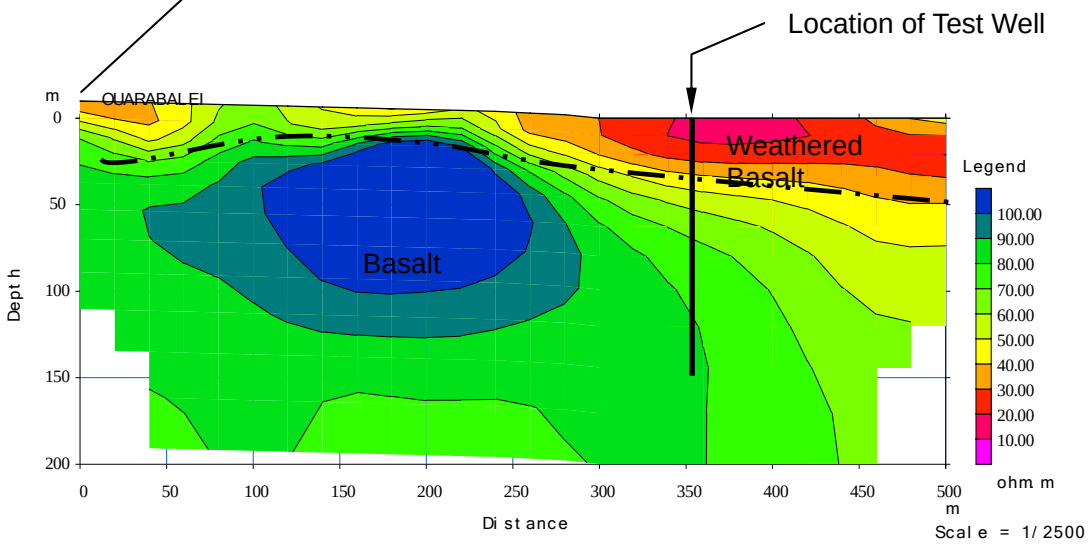




(30) OUARABALE

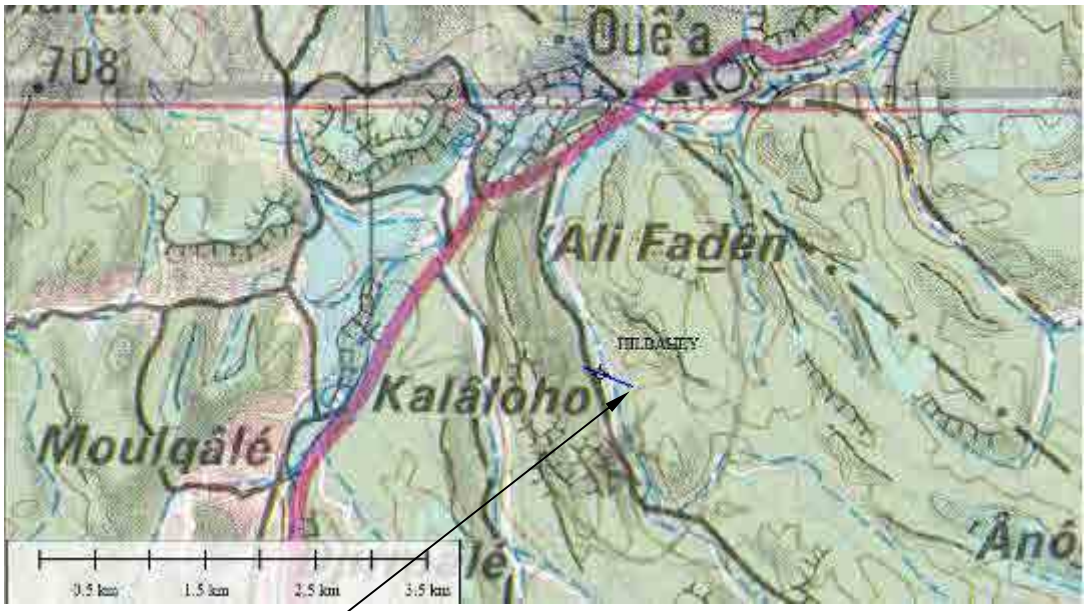
In this area, sedimentary rock is mainly observed while basalt is distributed in the upper stream area. Most of the catchment area is in Ethiopia and details are not clear. The results of electrical profiling show the wide spread of a high resistivity area of more than 60 Ω･m and a wide distribution of low permeable sandstone is estimated. Therefore, the potential for water development is anticipated to be low.

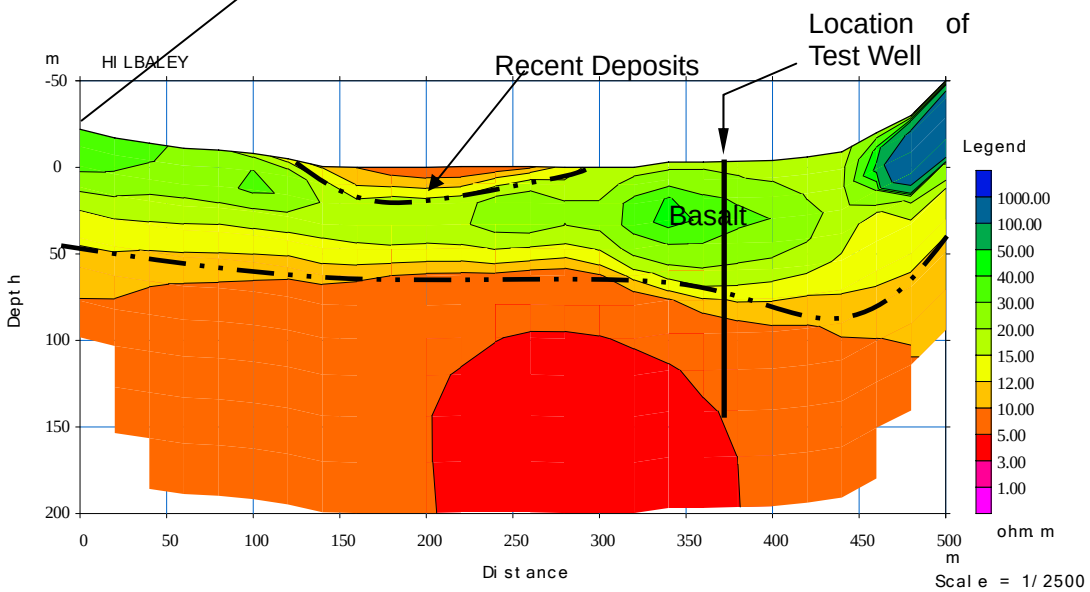




(31) HILBALEY

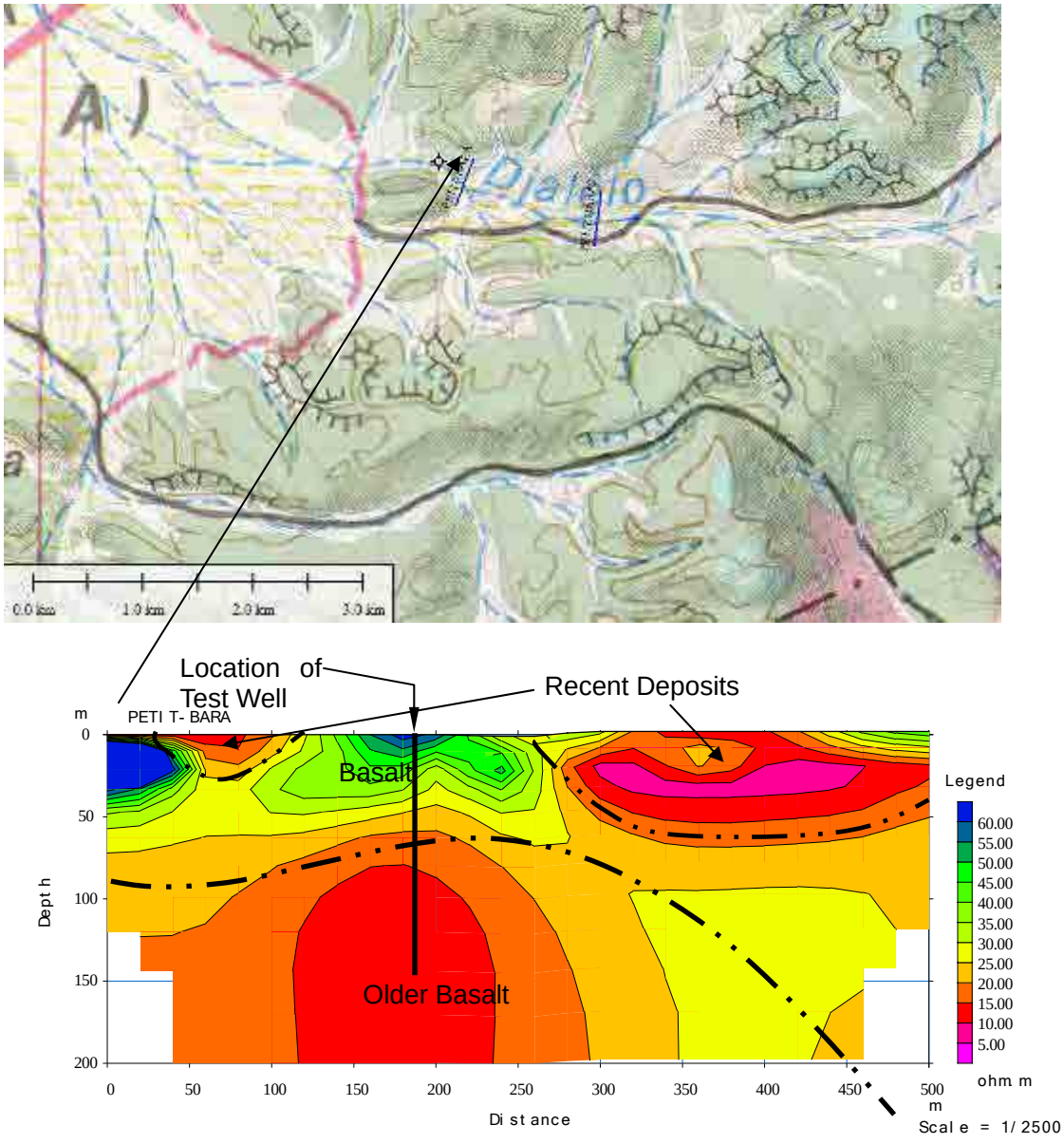
It is located in the middle stream of the AMBOULI watershed. It is surrounded by basalt plateaus and shows a suitable topography for collection of groundwater. The results of electrical profiling show distribution of a high resistivity zone of more than 20 Ω·m at a depth of shallower than 50 m and a wide distribution of highly permeable basalt is expected.
On the other hand, a low resistivity of less than 10 Ω·m is distributed at depths of more than 50 m. Therefore, the potential for water development is considered to be high while a high salt content is anticipated in cases where wells are deeper than 50 m.





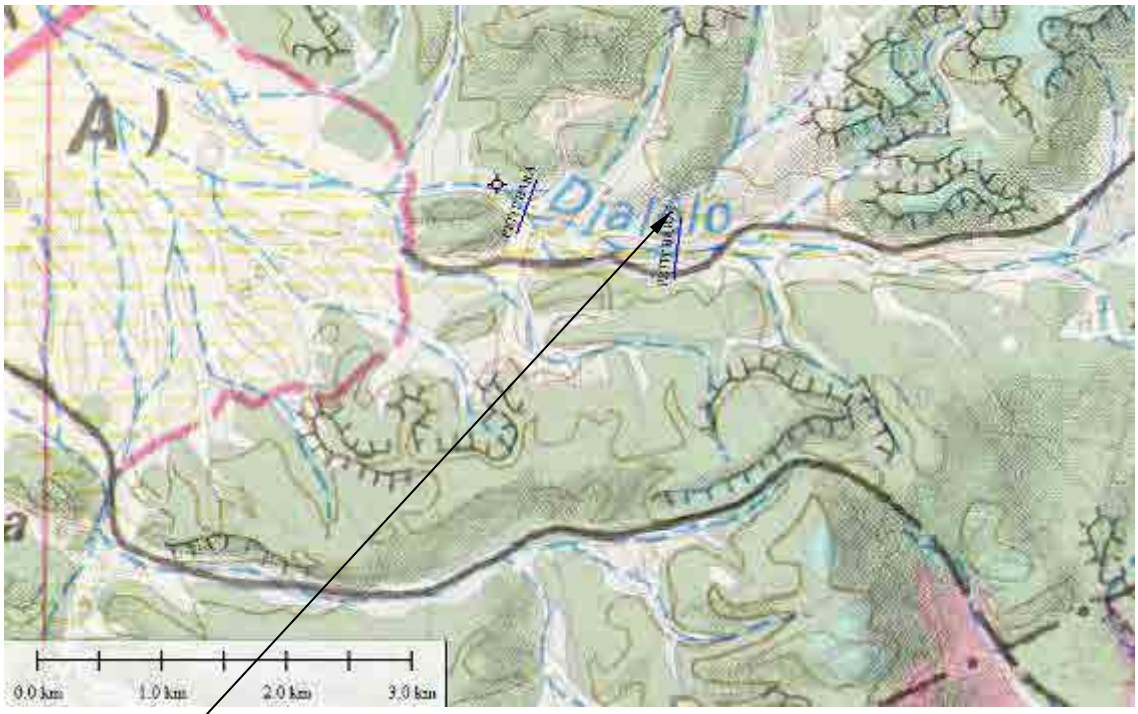
(32) PETIT BARA (1)

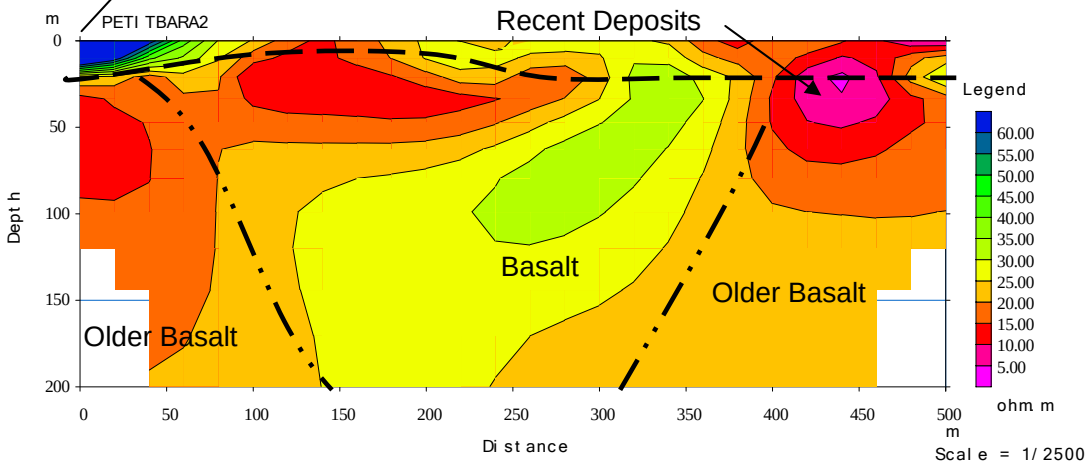
This measurement position is located at the upper stream of the AMBOULI watershed. It is surrounded by basalt plateaus and the topography shows a suitable shape for collection of groundwater.
Results of electrical profiling show the distribution of a high resistivity zone of more than 25 Ω·m to 100 m in depth for the first half (north side) of the profile line while a low resistivity zone of less than 25 Ω·m is observed at 100 m and deeper. On the other hand, for the latter half (south side) of the profile line, a low resistivity zone of less than 25 Ω·m is distributed to 100 m while high resistivity of more than 25 Ω·m is observed for 100 m and deeper.
The geological structure is difficult to interpret in this area. However, the width of the wadi is narrower than that of the upper stream area and the topography is suitable for collection of groundwater. Therefore, a Test Well was drilled at this point. As a result, older basalt was encountered at a depth of more than 100 m and a large production well will be developed in spite of the high salt content.



(32) PETIT BARA (2)

This measurement position is located at an upper stream of the AMBOULI watershed and is surrounded by basalt plateaus.
Results of electrical profiling show the distribution of a high resistivity zone of more than 20 Ω･m all over the area. There is low resistivity of less than 20 Ω･m at the north side of the former half of the profile line. This low resistivity section is estimated to be older basalt.





(33) PK30

This point is located in the middle stream of the AMBOULI watershed. It is surrounded by basalt plateaus and shows a relatively suitable topography for collection of groundwater. Cracks in the basalt in the surrounding area are well developed but are filled with calcite and low permeability is anticipated.
Through results of electrical profiling, a low resistivity zone of less than 20 Ω･m is observed at a distance of 300 m from the starting point (south) of the profile line. From the distance of 300 m to the end (north) of the line, high resistivity of more than 20 Ω･m is observed.

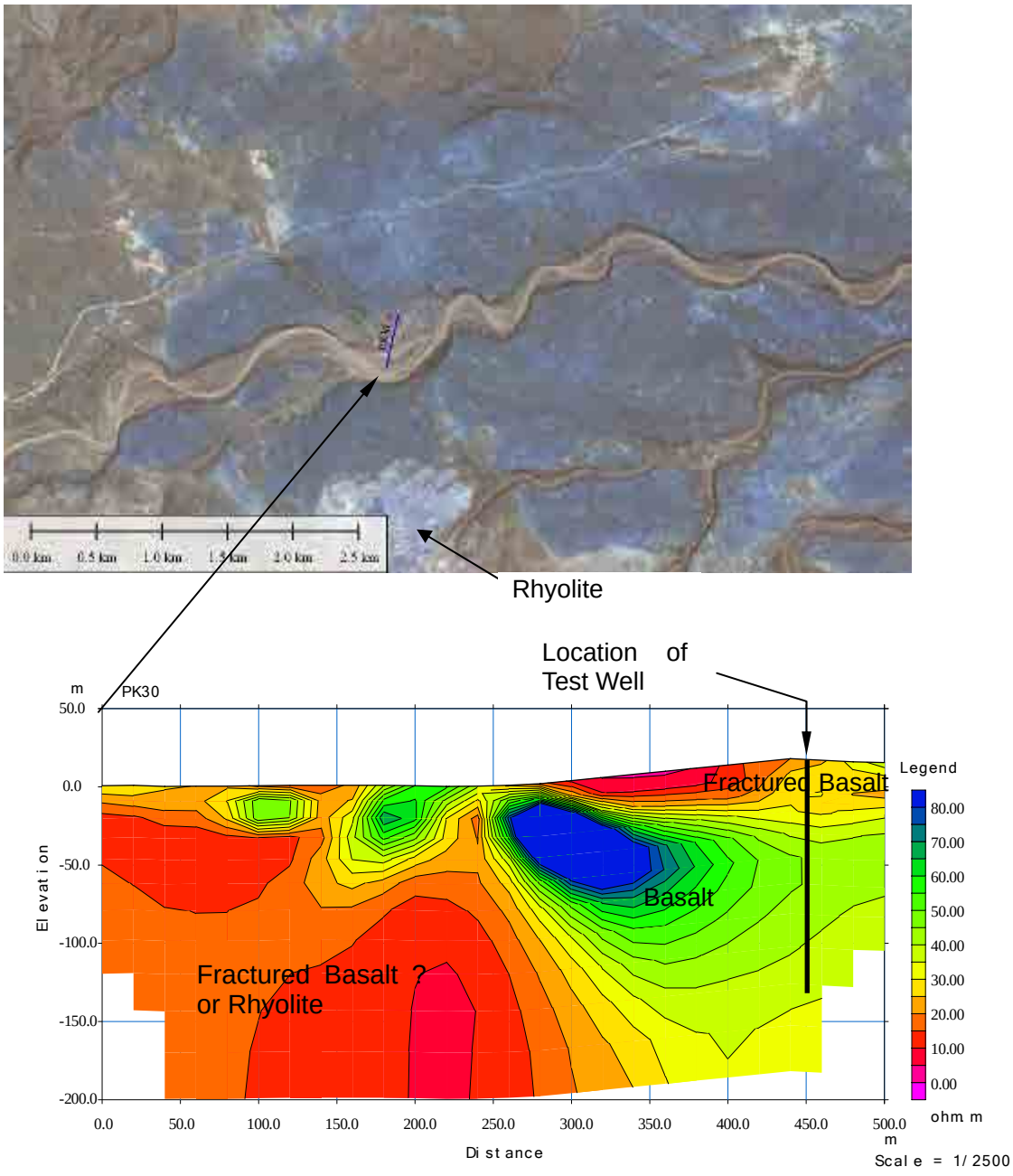


Table A7-1 Coordinates of the Survey Line

No	Site Name	Start		Middle1		Middle2		End	
		Longitude	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude	Latitude
1	UNDA YAGGOURI	175330	1278375					175413	1277928
2	UNDA YAGOURI-2	179707	1281789	179510	1281821			179225	1281744
5	GALLIHATAYATA	176048	1263844					175628	1264108
6	BALAMBALEY	219958	1231251	219879	1231069			219759	1230795
7	SANKAL	194366	1214605	194554	1214534			194847	1214527
8	ZINAMALE	191929	1228926					192041	1228542
9	KOUTABOUYA	170485	1219932					170572	1220424
11	DAGUIRO2	169321	1283062					169567	1283447
12	GALAFI	154438	1297123					154640	1297599
13	HOMBOLA	162302	1277775	162163	1277642			161993	1277411
15	SEK SABIR	197626	1247128	197468	1247005			197208	1246860
16	ASSA KOMA	179909	1224423					180132	1224022
17	MINDIL	219726	1240198	219576	1240065			219358	1239861
18	AFKA ARRABA	216847	1227042	216778	1226867			216665	1226593
21	HAMBOUCTA	246034	1240508	245841	1240480			245557	1240362
22	GUELILE	243772	1227159	243695	1227274			243385	1227466
23	MIDGAN	261086	1230364					261540	1230382
24	DIGRI	270745	1250472	270846	1250655	270902	1250698	271059	1250844
25	ASSAMO	263382	1215242					263765	1214921
26	DOUSSAGOUD MOUNE	265937	1219962	266135	1219987			266410	1220099
27	ALI ADDE	268001	1230131					267539	1229938
29	MIDGARRA	277646	1234687	277500	1234337			277423	1234252
30	OURABALEI	255563	1226539					255309	1226967
31	HILBALEY	265635	1269701					266084	1269516
32	PETIT BARA	258355	1256616					258197	1256189
32	PETIT BARA2	259522	1256308					259458	1255819
33	PK30	272189	1274262					272282	1274669

Source: JICA Study Team

Annex-8

Water Quality Test

A8-1. CLASSIFICATION OF WATER QUALITY IN THE PROJECT AREA

Trilinear diagrams of the major components (Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^- SO_4^{2-} and HCO_3^-) were drawn on the basis of analysis results. The trilinear diagram does not show their concentration but their composition ratios. The results show that the groundwater in the project area is classified as Type IV regardless of distribution depth. This means the groundwater has properties of seawater or fossil water. In the case of spring water, there is the remarkable tendency of a high concentration of sodium and chloride.

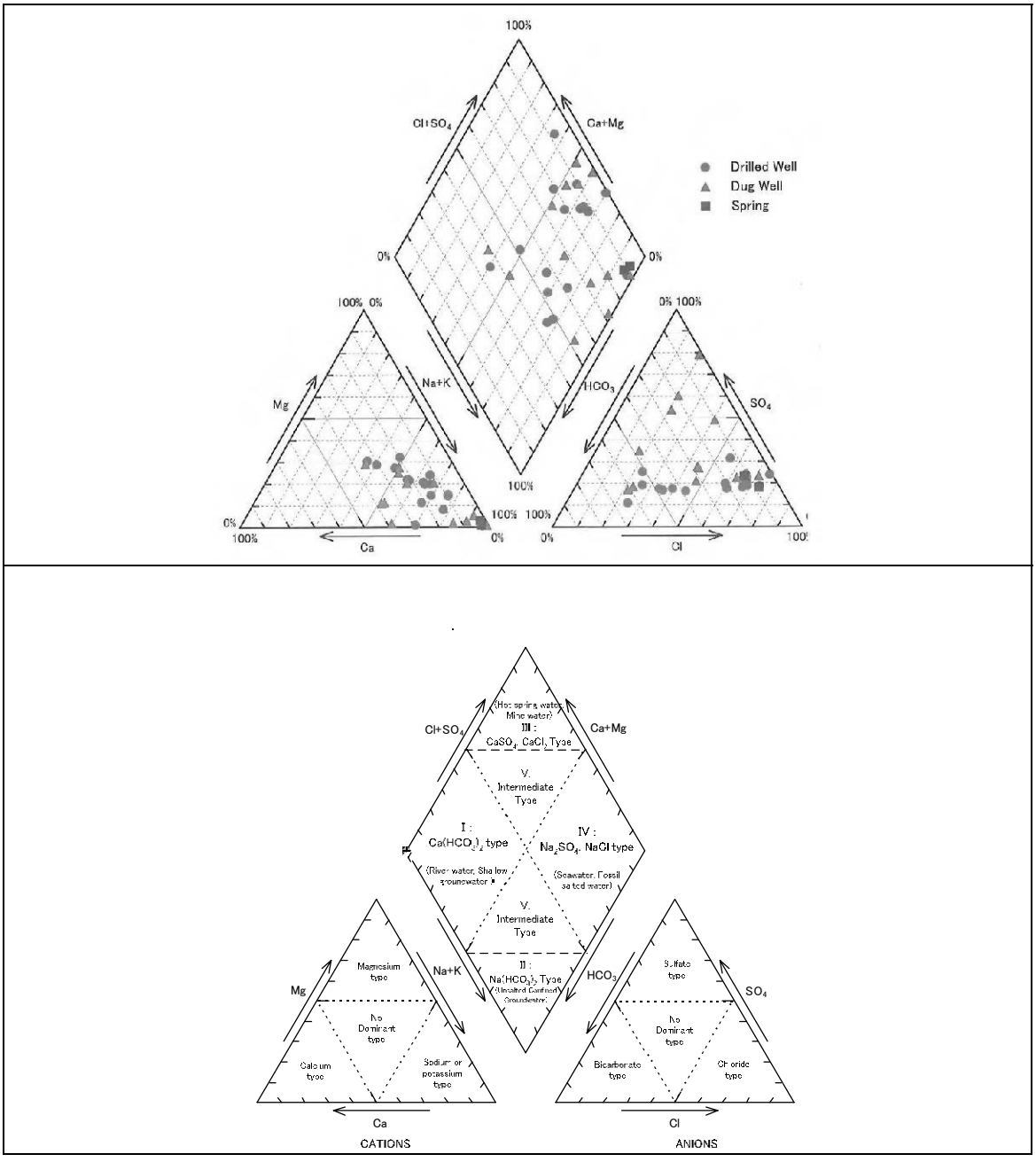


Figure A8-1 Classification of Water Quality in the Project Area with Trilinear Diagram

A-2. Desalination

1) Conditions for Consideration on Desalination Methods

a) Water Quality of Raw Groundwater

As is clear from the water quality survey results, the electric conductivity of raw groundwater for desalination is about 1,500 to 4,000 μS/cm. The main chemicals are chloride and sodium ions.

b) Groundwater Volume for Desalination

50～100 m³/day

2） Desalination Techniques and Applicability

Presently available desalination techniques are multi-stage flash distillation, multi-effect distillation and reverse osmosis. There are four kinds of membranes used for removal of dissolved solids. Since the main chemicals to be removed from raw groundwater in the project are chloride and sodium ions, the reverse osmosis membrane should be used.

Table A8-1 Function of Membrane Treatment

Name of Membrane	Function of Membrane
Microfiltration Membrane	Separation of particles of 100 nm～10 μm in diameter
Ultrafiltrarion Membrane	Separation of particles of more than several to several tens nm in diameter.
Nanofiltration Membrane	Separation of particles of more than one nm in diameter by electrostatic effect.
Reverse Osmosis Membrane	Separation of ions by applying pressure greater than osmotic pressure

Electrodialysis (ED) is another desalination technique. However, this technique was eliminated from consideration for desalination of Djibouti groundwater for the following reasons:

- The desalination efficiency is lower than the other techniques mentioned above. Because the groundwater in Djibouti is highly rich in salinity, this electrodialysis technique is not applicable.
- The existing operation rate is much lower than that of the other three techniques.

Table A8-2 shows the distinctive features and applicability to the project of the three selected desalination techniques.

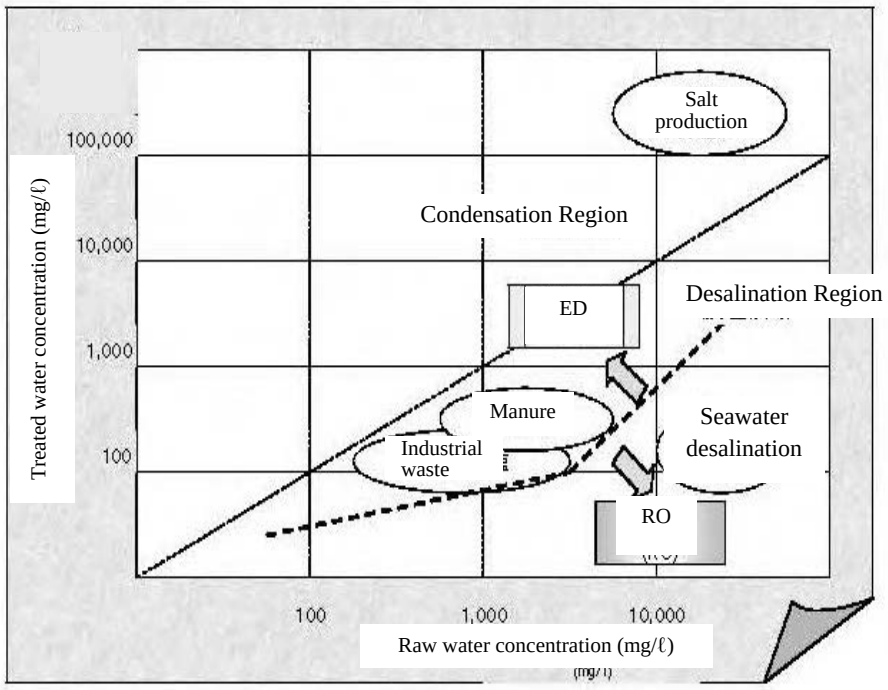


Figure A8-2　Possible Raw Water Quality of Electrodialysis（source：AGC Engineering）

Table A8-2 Comparison among Desalination Techniques

Desalination Technique	Multi-stage flash (MSF)	Multi-effect distillation (MED)	Reverse osmosis (RO)
Principle of Separation	Evaporation	Evaporation	Filtration by Membrane
	To make vapors from raw water to form fresh water by rapid lowering pressure below saturated pressure level.	Set a sequence of evaporation vessels, and the vapor boiled off in one vessel is used to heat the next one. Each vessel is maintained at a lower temperature than the last so that the boiling point of water decreases as pressure decreases.	Exerting a higher pressure than the osmotic pressure of the membrane to separate ions from raw water.
Running Cost	More expensive than RO for consumption of vapor	More expensive than RO for consumption of vapor	Cheaper than evaporation methods
Distinctive feature	Heat transfer efficiency is low so that much energy is required.	Heat transfer efficiency is low so that much energy is required.	Pre-processing is necessary to avoid clogging by sludge
Treated Water Quality	< 5 mg/ℓ	< 10 mg/ℓ	< 500 mg/ℓ
Applicability to drinking	Adding minerals is necessary.	Adding minerals is necessary.	Directly drinkable.
Isolated operation with electric power	Other heat source for evaporation is necessary.	Other heat source for evaporation is necessary.	Electric power only.
Electrical requirement (kWh/t-product)	3 - 5	1.5 – 2.5	2.5 - 5
Chemicals used	・ Scale prevention ・ Antifoam agent ・ Cleaning agent	・ Scale prevention	・ Scale prevention ・ Cleaning agent ・ Flocculation agent
Chemical Cleaning	At intermittent intervals	At rare intervals	At regular intervals
Maintenance	・ Regular cleaning ・ Maintenance of rotational parts	・ Maintenance of rotational parts	・ Regular cleaning ・ Maintenance of rotational parts ・ Periodical replacement of RO membrane ・ Periodical replacement of filter
Disposal of residue	Necessary	Necessary	Necessary
O & M workforce	Personnel knowledgeable about treatment system are necessary.	Personnel knowledgeable about treatment system are necessary.	Personnel knowledgeable about treatment system are necessary.
Manufactured products	Exist	Exist	Exist
Parts procurement	No agencies in Djibouti. Procurement of O & M parts is very difficult.	No agencies in Djibouti. Procurement of O & M parts is very difficult.	No agencies in Djibouti. Procurement of O & M parts is very difficult.
Existing plants	Steam condensation from electric power plants and associated gas from oil	MED is developed for salt production in Japan so that there are a lot of salt	Owing to the progress of energy saving technology for RO, RO is a major technique

	wells are used as thermal sources for evaporation. Therefore, many of the existing plants are constructed in Middle-East oil countries	production plants. Other usage is for pure water production in the pharmaceutical industry.	in the field of desalination at present, and is applied widely.
Applicability for the Project	Difficult for the following reasons: ・ No electric power supply ・ No thermal energy source for evaporation ・ No capacity for O & M in village or in Djibouti due to no existing plants in the country ・ Difficulty of parts procurement	Difficult for the following reasons: ・ No electric power supply ・ No thermal energy source for evaporation ・ No capacity for O & M in village or in Djibouti due to no existing plants in the country ・ Difficulty of parts procurement	Difficult for the following reasons: ・ No electric power supply ・ No capacity for O & M in village or in Djibouti due to no existing plants in the country ・ Difficulty of parts procurement

3） Information obtained in Djibouti

i) UNICEF, which has been practically functioning as a representative of donors in Djibouti, gave its view on desalination, “there are no desalination techniques applicable to groundwater treatment.”

ii) The government of Djibouti did not request the use of desalination plant in the field of rural water supply.

4） Position of the project team for desalination

A desalination plant is very complicated to operate, and there are no capable agencies in Djibouti. In addition,

i) It is very difficult to procure materials for operation and maintenance such as equipment for replacement, spare parts and solution detergents.

ii) There are few or no engineers or technicians knowledgeable about desalination plants.

For all of these reasons, O & M of a desalination plant is very difficult for villagers. MAEM-RH also does not have capacities in the two respects mentioned above. Therefore, desalination techniques cannot be applied to the rural water supply project.

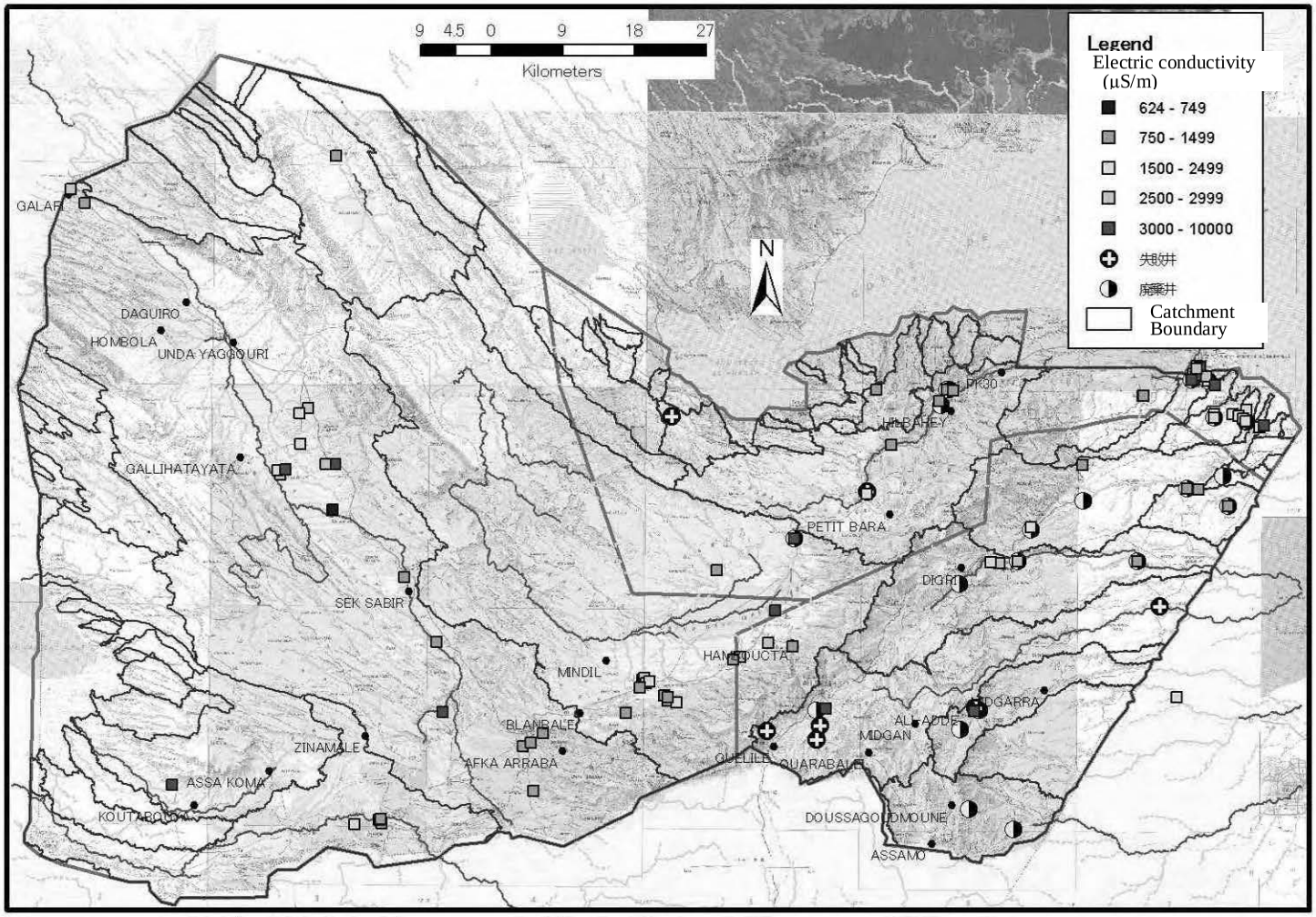


Figure A8-3 Water Quality of Existing Boring Wells — Electric Conductivity

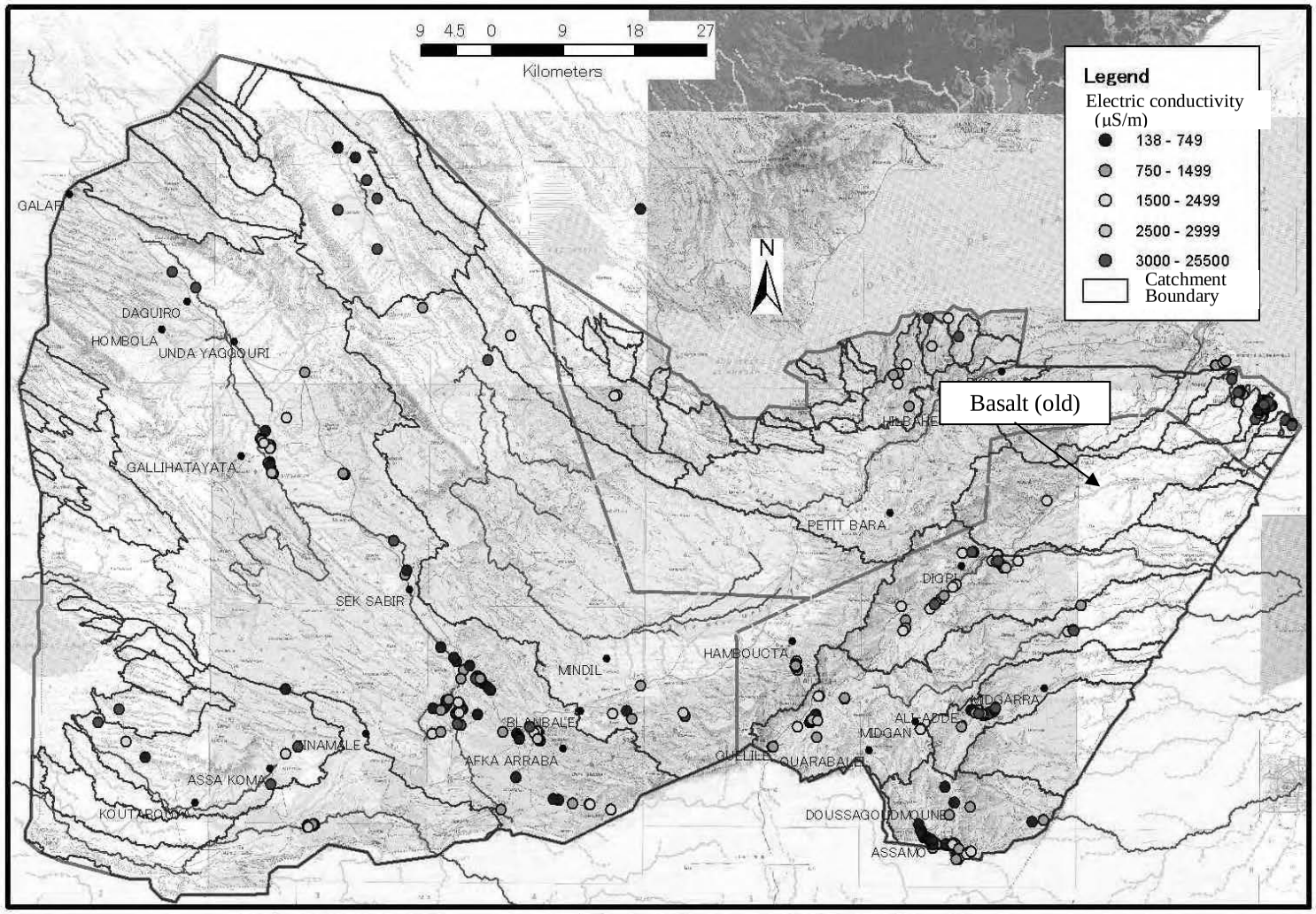


Figure A8-4 Water Quality of Existing Hand Dug Wells — Electric Conductivity

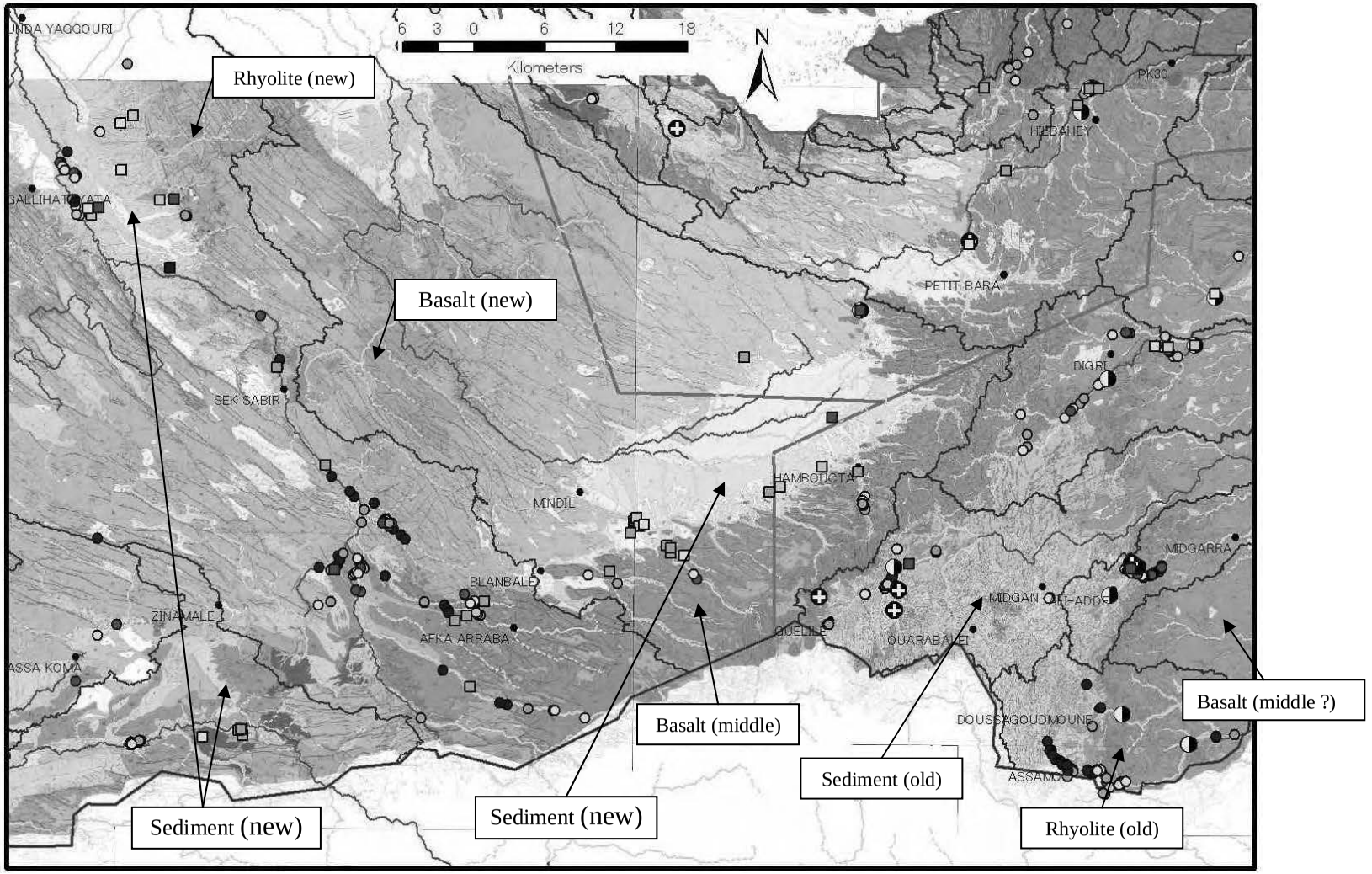


Figure A8-5 Relation between Geological Feature and Water Quality (Electric Conductivity)

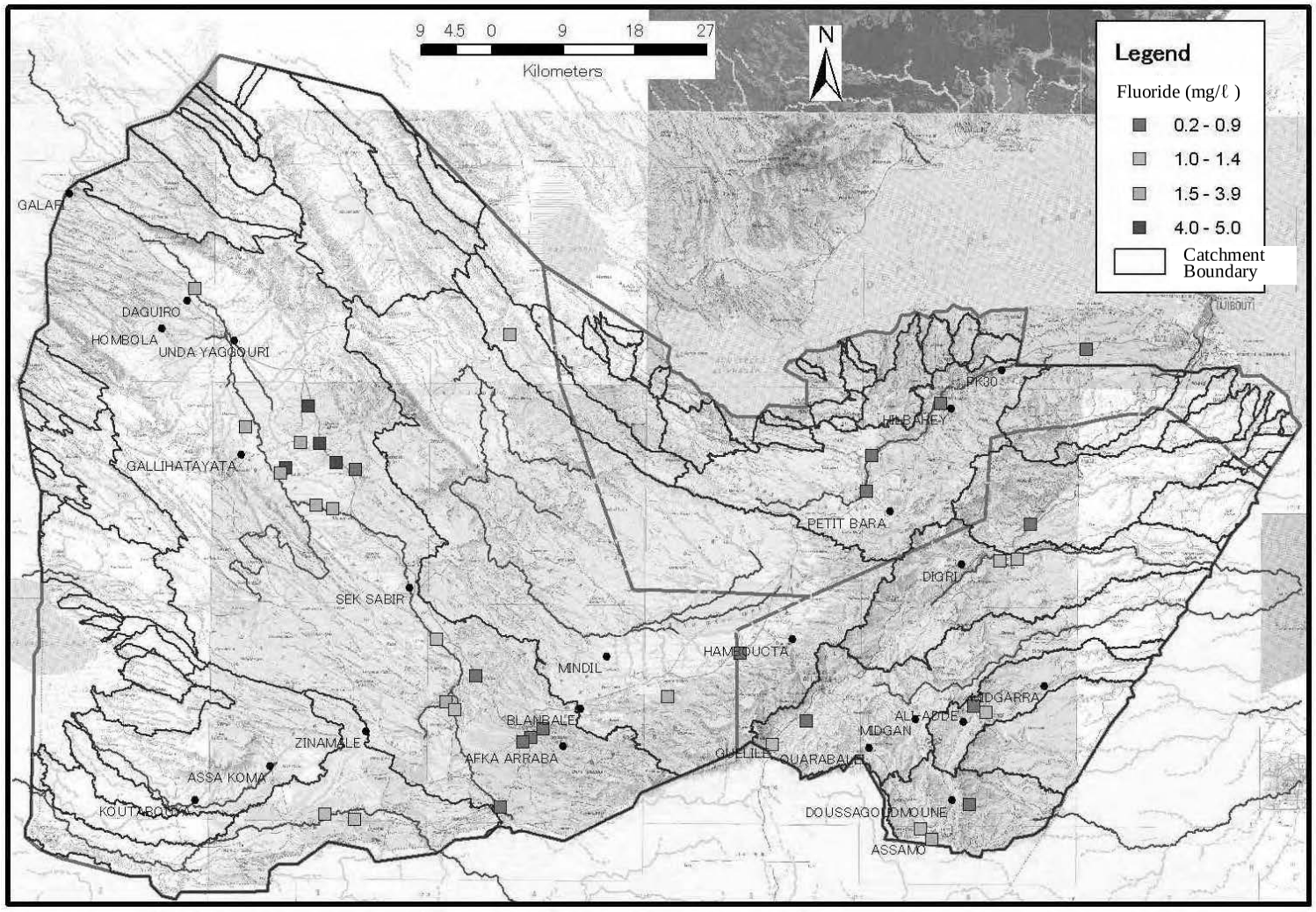


Figure A8-6　Fluoride: Laboratory Water Quality Test for Existing Wells (partially including existing data.)

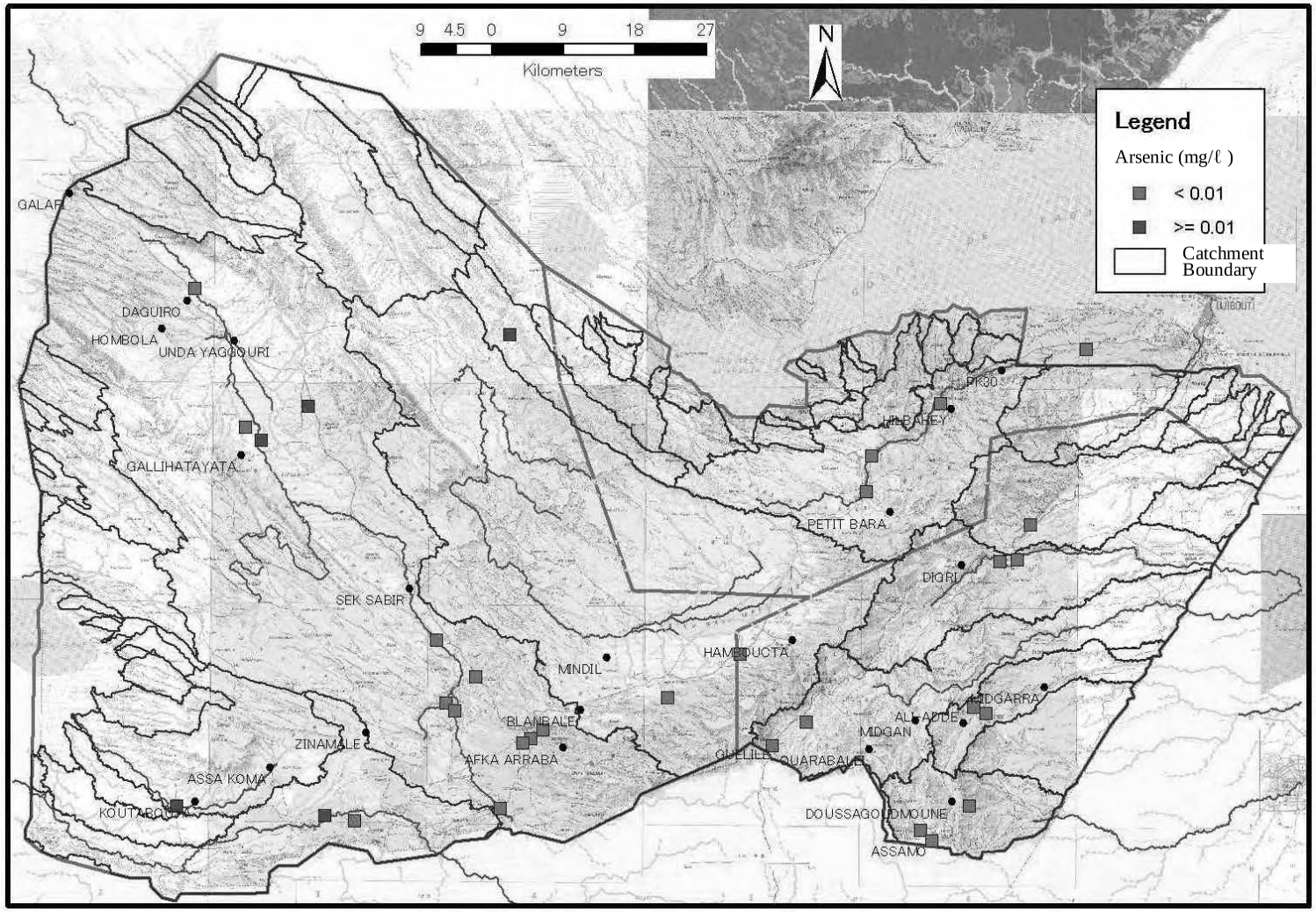


Figure A8-7 Arsenic: Laboratory Water Quality Test for Existing Wells

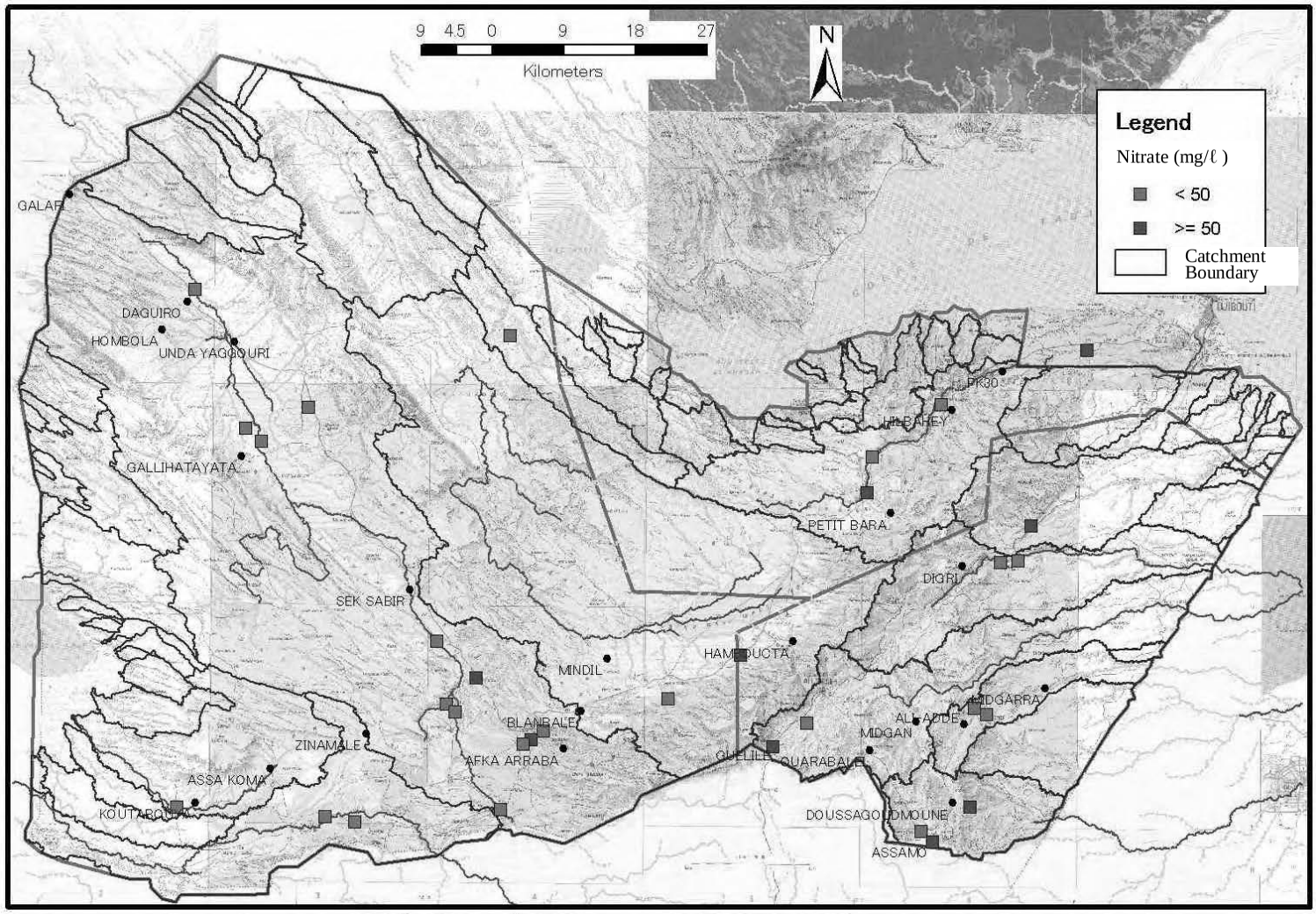


Figure A8-8 Nitrate: Laboratory Water Quality Test for Existing Wells

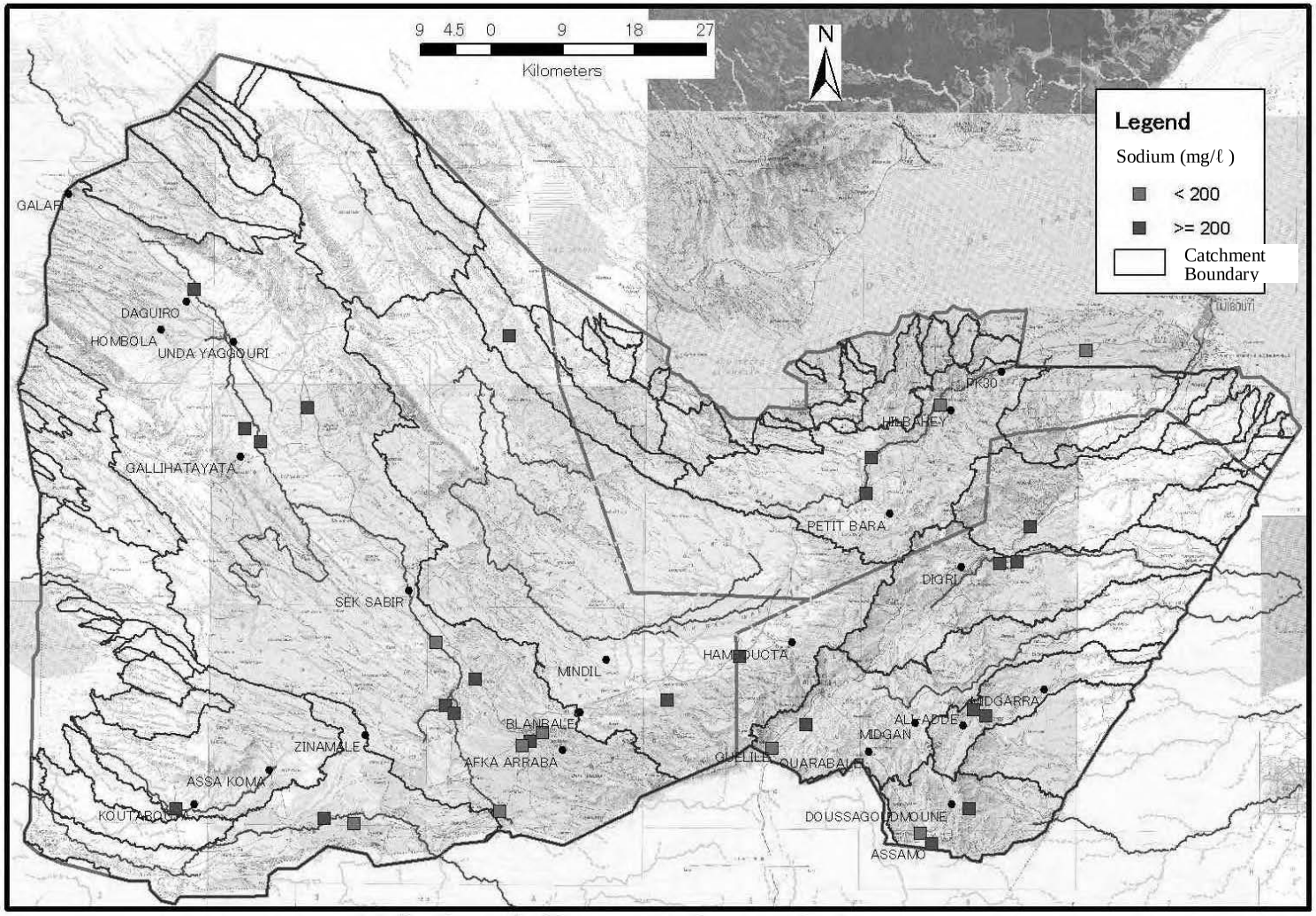


Figure A8-9 Sodium: Water Quality Test for Existing Wells

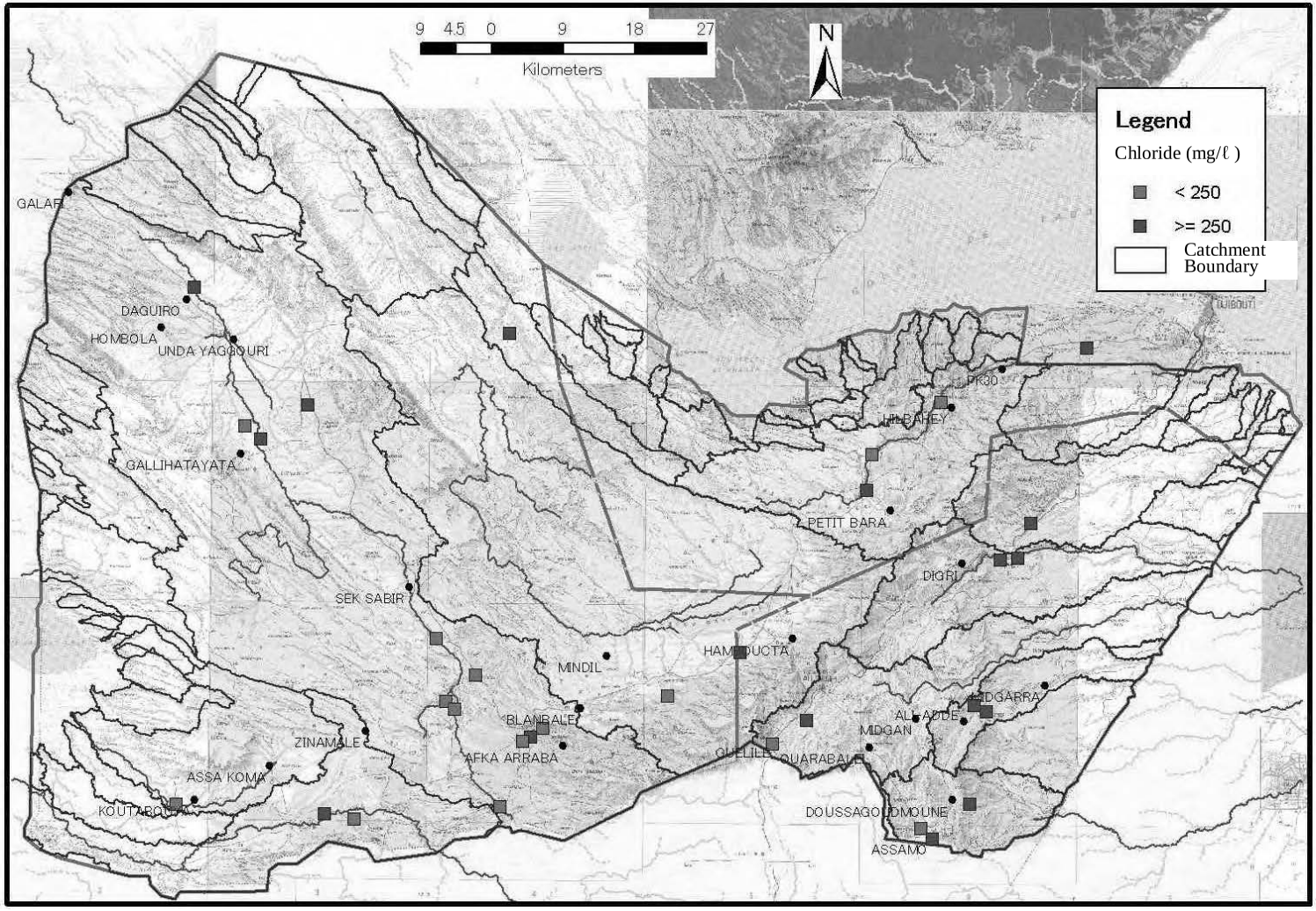


Figure A8-10 Chloride: Laboratory Water Quality Test for Existing Wells

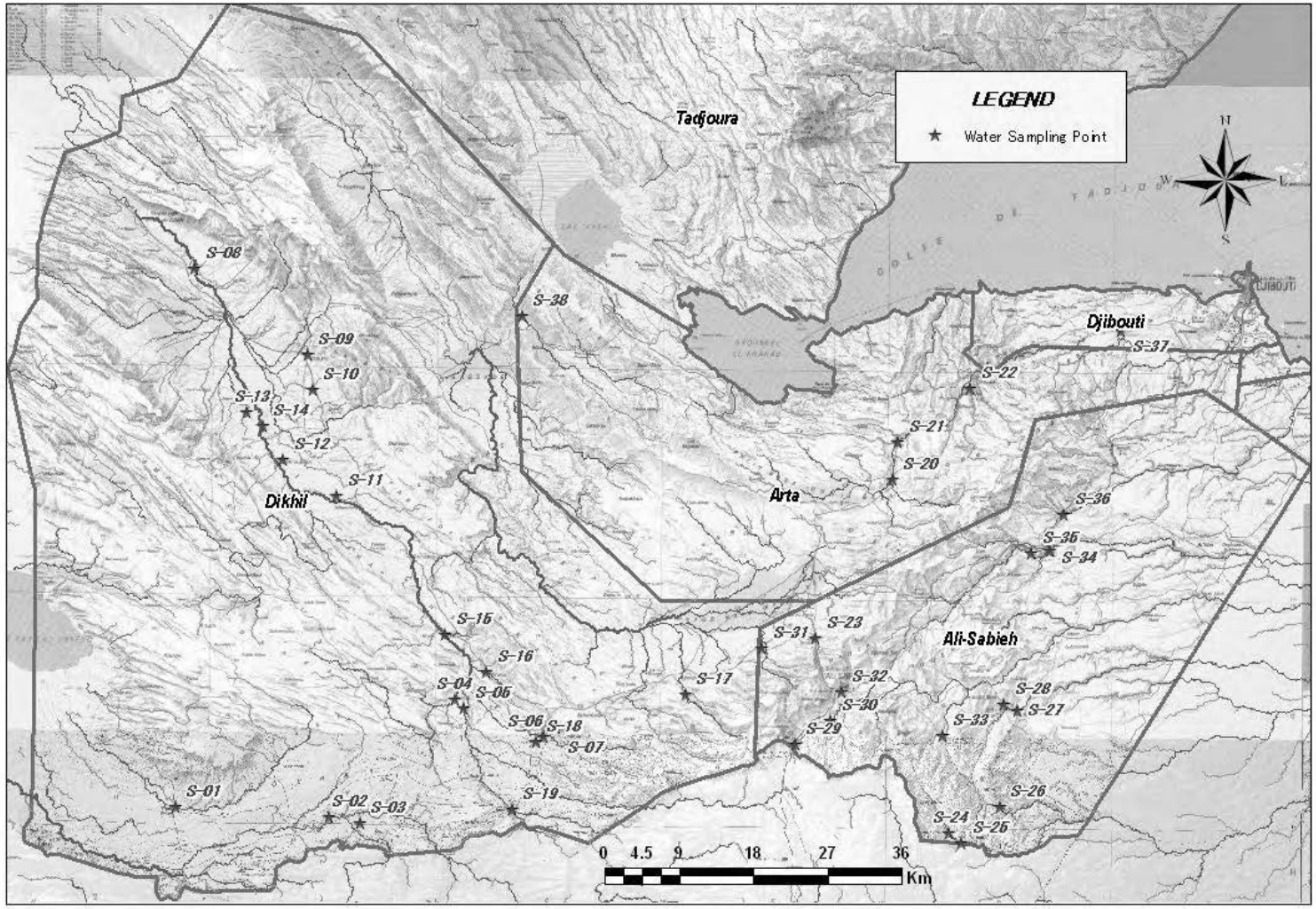


Figure A8-11 Location Map of Existing Wells for Water Quality Survey

Table A8-3 Results of the Water Quality Test

Sample No.	Date	Region	Village	Well Name	Latitude	Londitude.	Well Type	pH	EC (μS/cm)	TDS (mg/l)	Bicarbonates HCO3- (mg/l)	Chlorures Cl- (mg/l)	Residu Sec (mg/l)	Fer Fe (mg/l)	Arsenic As (mg/l)	Sodium Na+ (mg/l)	Calcium Ca2+ (mg/l)	Potassium K+ (mg/l)	Magnesium Mg2+ (mg/l)	Carbonates (mg/l)	Nitrates NO3 (mg/l)	Fluoride (mg/l)	Sulphate SO42- (mg/l)
S-01	2010/2/7	Dikhil	Kouta Bouya	Kouta Bouya	11.01710	41.96336	Dug	8.55	1731	1108	183	114	1157	< 0.01	0.0192	327	25	3	5	530	28	5.4	450
S-02	2010/2/7	Dikhil	Sissalou	Abdoulkader Hassan Med	11.00733	42.13378	Dug	8.90	8041	5146	431	986	5682	< 0.01	0.0127	1906	10	15	10	2140	9	1.2	1600
S-03	2010/2/7	Dikhil	unknown	JICA	11.00206	42.16806	Drilled	8.40	863	552	284	76	554	< 0.01	< 0.01	153	25	4	8	324	7	1.1	110
S-04	2010/2/7	Dikhil	Kontali	Kontali	11.13753	42.27261	Dug	8.45	1593	1020	467	99	1016	< 0.01	< 0.01	341	12	1	11	540	13	3.3	270
S-05	2010/2/7	Dikhil	Chekheti	Chekheti	11.12815	42.28245	Dug	9.25	3270	2093	< 60	202	2495	< 0.01	< 0.01	484	275	16	7	584	40	1.0	1100
S-06	2010/2/7	Dikhil	Dikhil 11 (Halou)	ONEAD	11.09772	42.37088	Drilled	7.75	2060	1318	308	512	1613	< 0.01	< 0.01	288	103	3	102		120	0.5	230
S-07	2010/2/7	Dikhil	Cheick Mandaytou	ONEAD	11.10713	42.38450	Drilled	8.10	993	636	288	118	633	< 0.01	< 0.01	115	51	2	34		33	< 0.50	82
S-08	2010/2/8	Dikhil	Daguirou	Daguirou	11.60635	41.97812	Spring	8.25	3090	1978	179	919	2227	< 0.01	< 0.01	758	20	29	3		3	3.8	300
S-09	2010/2/8	Dikhil	Yoboki	Yoboki	11.51313	42.10492	Dug																
S-10	2010/2/8	Dikhil	Kouhou Lyeta	Kouhou Lyeta (JICA)	11.47419	42.11063	Drilled	8.25	2061	1319	164	552	1519	< 0.01	0.0128	487	12	24	1		2	4.5	240
S-11	2010/2/8	Dikhil	Koudi Kouda	Koudi Kouda Hanle 1	11.35838	42.13913	Drilled																
S-12	2010/2/8	Dikhil	Liliya Bouri	Liliya Bouri Hanle 1	11.39820	42.07867	Drilled																
S-13	2010/2/8	Dikhil	Agna Hanle	Bako Bouyi	11.44916	42.03800	Dug	8.00	1191	762	183	173	720	0.013	< 0.01	209	30	5	3		22	3.9	140
S-14	2010/2/8	Dikhil	Tewoo	Tewoo (Unicef)	11.43400	42.05598	Dug	8.60	5430	3475	876	808	3714	0.015	0.0163	1219	9	9	3	1560	46	6.8	680
S-15	2010/2/9	Dikhil	Galamo	Galamo	11.20900	42.26100	Drilled	8.05	863	552	299	85	536	0.016	< 0.01	149	16	3	16		29	1.0	83
S-16	2010/2/9	Dikhil	Ab aitou	Ab aitou	11.16733	42.30678	Dug	7.95	1496	957	272	234	906	< 0.01	< 0.01	223	35	4	36		50	0.8	140
S-17	2010/2/9	Dikhil	Lobleh Guedi	Dhadhine	11.14513	42.52780	Drilled	7.75	1366	874	393	174	871	< 0.01	< 0.01	217	44	5	25		31	1.7	110
S-18	2010/2/9	Dikhil	Dikhil	ONED-F8	11.09235	42.36211	Drilled	8.05	1021	653	253	135	627	< 0.01	< 0.01	147	32	3	24		44	< 0.50	81
S-19	2010/2/9	Dikhil	Bondara	Bondara	11.01798	42.33630	Dug	7.45	852	545	132	64	587	< 0.01	< 0.01	96	63	5	11		21	0.8	220
S-20	2010/2/11	Arta	Petit Bara	Petit Bara	11.38167	42.75554	Drilled	8.15	2860	1830	239	629	1708	< 0.01	< 0.01	382	86	8	66		63	< 0.50	230
S-21	2010/2/11	Arta	PK-51	PK-51	11.42247	42.76125	Drilled	8.40	1204	771	276	190	713	< 0.01	< 0.01	202	22	4	20	299	17	0.8	93
S-22	2010/2/11	Arta	Hilbahey	USA	11.48273	42.84139	Drilled	7.70	587	376	366	82	606	< 0.01	< 0.01	90	60	2	34		42	0.7	49
S-23	2010/2/13	Ali-Sabieh	Ham Boucta	Chinse Well	11.20779	42.67173	Drilled																
S-24	2010/2/14	Ali-Sabieh	Assamo	Dawane Bah	10.99649	42.82122	Dug	7.90	587	376	228	47	372	< 0.01	< 0.01	49	43	3	22		39	1.1	50
S-25	2010/2/14	Ali-Sabieh	Assamo	Hospital	10.98505	42.83503	Drilled	8.05	5310	3398	398	995	3536	< 0.01	< 0.01	796	127	2	157		140	2.5	760
S-26	2010/2/14	Ali-Sabieh	Doussgoudmoune	DoussAgoudmoune	11.02524	42.87725	Dug	7.70	5400	3456	183	1310	3471	< 0.01	< 0.01	641	260	7	167		52	0.8	580
S-27	2010/2/14	Ali-Sabieh	Ali Adde	Puit zone 5	11.13065	42.89574	Dug	7.65	3737	2392	215	839	2355	< 0.01	< 0.01	465	166	8	87		31	1.2	420
S-28	2010/2/14	Ali-Sabieh	Ali Adde	UNHCR	11.13680	42.88162	Drilled	7.65	5820	3725	272	1510	3854	< 0.01	< 0.01	482	392	2	215		27	0.7	520
S-29	2010/2/15	Ali-Sabieh	Galileh	Puit Galileh	11.09194	42.64981	Dug	8.00	890	570	342	79	527	< 0.01	< 0.01	110	43	1	32		53	1.0	85
S-30	2010/2/15	Ali-Sabieh	ONED	ONED	11.11844	42.68870	Drilled	7.90	5700	3648	< 60	1420	3450	0.039	< 0.01	870	316	3	6		2	< 0.50	610
S-31	2010/2/15	Ali-Sabieh	Aour Aoussa	Aour Aoussa	11.19595	42.61181	Drilled	8.05	2540	1626	152	549	1609	0.015	< 0.01	304	105	11	64		100	0.6	270
S-32	2010/2/15	Ali-Sabieh	Fuabtrer Iljano	Fuabtrer Iljano	11.14884	42.70055	Dug																
S-33	2010/2/15	Ali-Sabieh	Molid	Molid 2	11.10300	42.81300	Dug																
S-34	2010/2/17	Ali-Sabieh	Holl-Holl	P.Communaute	11.30595	42.93093	Dug	7.95	2680	1715	235	576	1706	< 0.01	< 0.01	301	184	5	35		32	1.2	280
S-35	2010/2/17	Ali-Sabieh	Holl-Holl	Osdan Doubleh	11.30318	42.91067	Drilled	8.20	2310	1478	165	506	1340	< 0.01	< 0.01	326	93	8	29		18	1.1	230
S-36	2010/2/17	Ali-Sabieh	Hindi	Hind F1 (New)	11.34536	42.94577	Drilled	8.50	3260	2086	228	730	1950	< 0.01	< 0.01	468	86	9	74	466	74	0.8	270
S-37	2010/2/18	Djibouti	PK-20	PK-20-RIIGA	11.54634	43.00843	Drilled	7.75	1564	1001	186	311	950	< 0.01	< 0.01	188	63	10	38		59	0.6	120
S-38	2010/2/18	Dikhil	Yoboki	Allouli	11.55695	42.34269	Spring	8.80	4390	2810	284	939	2551	< 0.01	0.0104	870	18	15	14	1230	2	3.3	450
JW-1		Dikhil	Unda Yaggouri (2)	Unda Yaggouri (2)			Drilled																
JW-2	2010/11/3	Dikhil	Sabbalou	Sabbalou	11.00350	42.20873	Drilled	8.10	920	620	260	71		<0.1	0.001	160	29	5.0	12.0		11	0.88	150
JW-3	2010/9/29	Dikhil	Zina Male	Zina Male	11.10118	42.18067	Drilled	7.90	1000	700	300	97		0.36	<0.001	150	27	9.6	40.0		78	0.80	97
JW-4	2010/8/12	Dikhil	Daguiro (2)	Daguiro (2)	11.59117	41.96897	Drilled	7.85	4550	3852	255	1000	2690	0.07	<0.01	884	21	59.4	4.4		3	4.00	350
JW-5	2010/10/27	Dikhil	Sek Sabir	Sek Sabir	11.26918	42.22931	Drilled	8.00	1000	650	280	97		<0.1	<0.001	170	22	7.5	22.0		25	0.92	110
JW-6	2010/11/5	Dikhil	Assa Koma	Assa Koma	11.06161	42.07052	Drilled	8.20	2100	1400	230	320		<0.1	0.005	920	14	21.0	3.8		17	3.90	410
JW-7	2010/11/1	Dikhil	Mindil	Mindil	11.20660	42.43183	Drilled	7.80	2600	1700	230	510		<0.1	<0.001	370	56	11.0	95.0		51	0.66	340
JW-8	2010/10/23	Dikhil	Afka Arraba	Afka Arraba	11.08629	42.40719	Drilled	7.90	790	540	300	68		0.86	<0.001	100	52	2.2	18.0		27	0.40	40
JW-9	2010/10/4	Ali-Sabieh	Hambocta	Hambocta	11.21184	42.67193	Drilled	7.90	730	520	210	68		<0.1	0.001	120	21	3.8	12.0		42	1.10	47
JW-10	2010/10/7	Ali-Sabieh	Guelile	Guelile			Drilled	7.90	3400	2200	63	780		0.23	<0.001	620	110	3.4	17.0		19	0.58	550
JW-11	2010/8/20	Ali-Sabieh	Midgarra	Midgarra	11.16117	42.96377	Drilled	7.40	4310	2648	306	910	2820	0.28	<0.01	633	180	10.4	84.5	0	37	2.00	450
JW-12	2010/8/17	Ali-Sabieh	Ouarabalei	Ouarabalei			Drilled	7.10	8370	7085	360	2100	6620	0.47	<0.01	923	494	7.5	384.0	0	12	0<0.5	680
JW-13		Arta	Hilbahey	Hilbahey			Drilled																
JW-14	2010/8/4	Arta	Petit Para	Petit Para			Drilled		4910	3720	138	920	3490	0.04	<0.01	494	214	9.2	193.0	0	240.0	<0.50	330
JW-15	2010/8/3	Arta	PK30	PK30			Drilled	7.80	621	341	116	42	398	0.06	<0.01	63	23	6.1	9.1	682	8.6	0.73	70

Sample No. S : Existing Water Source, JW : JICA Study